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ABSTRACT

This guide is designed to assist teachers in involving students in individual or small group laboratory investigative experiences in the life sciences. Each of the 22 experiments contains a prelab and postlab section for teachers and a detailed procedures section for students. (Author/CO)

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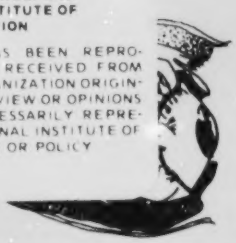

LIFE SCIENCE

an activity guide

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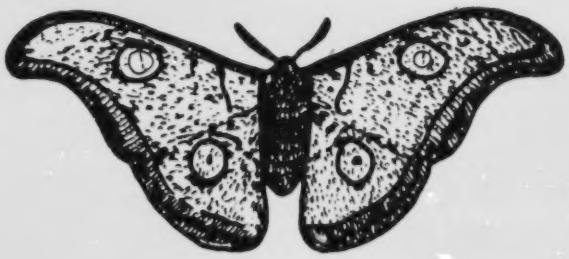

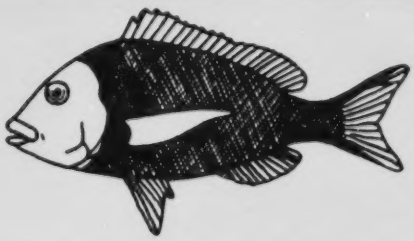

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LIFE SCIENCE
AN ACTIVITY GUIDE

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Foreword

Life Science, An Activity Guide was prepared by science teachers and supervisors of Texas public schools to offer instructional material that will maximize students' laboratory experiences in the life sciences.

The *Guide* is designed to assist teachers in involving students in individual or small group laboratory investigative experiences. Such laboratory experiences should build positive attitudes toward science and help students succeed in the modern world.

Alton O. Bowen
Commissioner of Education

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Contents

LABORATORY TIPS

Use and Care of Plants and Animals 3
Use of Aquariums in the Laboratory 12
Laboratory Safety Practices for Students 15

INVESTIGATIONS

Scientists at Work 19
Using a Scientific Method to Solve a Problem 25
An Introduction to the Compound Microscope 31
Using a Compound Microscope 37
Preparing Temporary Slides 41
Cells: An Investigation 45
Water Organisms in a Food Pyramid 49
Organisms in the Soil 53
A Population 57
Using Color to Survive in Nature 61
Earthworms: Response to Stimuli 66
Behavior and Environment 70
Ants and Their Senses 75
Humus in the Soil and Its Effects in Growth of Plants 79
Photosynthesis in Plants 83
Effects of Detergents on Growth of Algae 88
Digestive Heat 91
Action of Enzymes on Milk 94
Hereditary Traits 97
Reproduction and Growth 102
Noise Pollution 109
Particulate Matter in the Air 112

Laboratory Tips

Use and Care of Plants and Animals

Live animals and plants are essential to the study of the life sciences. Their indiscriminate use and care in the classroom, however, may introduce students to unnecessary safety hazards. Outside the classroom, additional hazards are present that must be taken into consideration prior to conducting outdoor investigations and field trips.

ANIMALS IN THE LABORATORY

Live animals should be used in the classroom if students are to fully understand and appreciate life processes. Students, regardless of age, need ample opportunities to observe and experiment with living organisms. The teacher should establish and review with students safety procedures prior to handling living organisms. This protects students and helps ensure the humane treatment of animals.

The following guidelines should be observed to ensure the humane treatment of animals in laboratory investigations:

- When living organisms are needed, use species such as plants, bacteria, fungi, protozoa, worms, snails, or insects. They are readily available, simple to maintain, and easy to dispose of, making them especially suitable for student work.
- Never use a procedure on a warmblooded animal that might cause it pain or any type of discomfort.
- Never perform surgery on a living vertebrate animal.
- Do not perform experiments with vertebrates that inflict harm, disease, or discomfort.
- Student experiments involving the observation of animals must be directly supervised by the teacher.
- All animals used for study must be properly fed, given sufficient water to drink, provided with ample living space, and handled humanely at all times.
- Embryos used for investigation must be killed no later than the 19th day of incubation. If embryos are to be hatched, proper arrangements must be made for the care or humane disposal of the chicks.
- All mammals used in the classroom must have been inoculated for rabies.

The following general safety recommendations regarding the use of animals in the classroom should be observed:

- Avoid using animals that pose infectious hazards such as wild rabbits, snapping turtles, poisonous snakes, or insects suspected to be disease carriers.
- Do not permit students to bring pets to the classroom unless the activity has been carefully planned.
- Have students wash their hands with soap and water after handling animals.
- Caution students never to tease animals.
- Return native animals to their environment after the observation period.

The following recommendations apply to specific types of animals normally used in the classroom:

Mammals

Care:

- Cages shall be cleaned and disinfected a minimum of once per week.
- Cages shall be draft-free with secure lids and/or doors to prevent escape or unauthorized handling.

Handling:

- Remove mice and gerbils from cage by grasping the base of the tail; support body with the other hand.
- Remove guinea pigs by grasping the forequarters with one hand and placing the other hand underneath the hindquarters.
- Hamsters should be removed by grasping the nape of the neck—"scruff of the neck"—between thumb and forefinger.
- Do not grab a small mammal around the major portion of the body as this usually results in a bite.
- Do not free small mammals to explore table tops or other areas where falls or injury may occur.
- Handle all small mammals gently and quietly; never squeeze them.

Reptiles

Care:

- Keep native reptiles in cages with very secure tops and/or doors to prevent their escape. Be sure there are no openings or loose fitting tops through which reptiles could escape.
- Make cages of solid wall construction with one side modified for ventilization.
- Maintain a temperature in a 78-85°F (25.5-29.4°C) range.
- Construct cages of appropriate size to allow exercise.
- Be sure that the wire mesh used for ventilation is of sufficient size to prevent escape.
- Clean and disinfect cages once each week.
- Provide a water bath.
- Know the nutritional requirements of each reptile and provide the appropriate amounts of food at weekly intervals.
- Some reptiles require small mammals for feeding. Be sure to remove uneaten ones after it is determined that the reptile is not going to feed.

- Never disturb a feeding reptile, especially snakes. When disturbed, the reptile may regurgitate the food and strangulation is possible.

- Never allow fecal material from reptiles to be placed in sinks, drinking vessels, or any lab equipment used by humans. Irritating infection of mucous membranes may result.

Handling:

- When tame snakes are handled, take care not to squeeze them. To remove a snake from its cage, place one hand under the first third of its body, the other hand slightly past the animal's center, and remove it gently.

- Never allow untrained persons to handle snakes known to bite.

- Move with caution in the presence of a snake. Rapid, sudden movements may induce a strike from even a tame snake.

- A snake is about to shed when its eyes are cloudy. To avoid a possible bite, never handle a snake until the shedding process is complete.

- Unless immediate supervision is present, NEVER keep poisonous reptiles in the classroom. To do so may be in violation of local school board regulations.

- Never examine freshly killed poisonous reptiles without immediate supervision. A reflex bite may be sustained.

- Handle lizards by grasping the full body in one hand, firmly, but gently. Never attempt to pick up a lizard by the tail.

- Most tortoises may be held by placing both hands on the edge of the top shell and curling the fingers around the edges to the lower shell. Loggerheads and softshell turtles should be handled with care and then only by persons knowledgeable in such procedures. Wash hands thoroughly with soap and water after handling turtles; they are carriers of Salmonella.

- Return native reptiles to their natural environment after observing them.

A state permit, available from the Environmental Branch, Permit Section, Texas Parks and Wildlife Department, is required for possession of a protected animal or if unusual trapping techniques are to be employed in capture of native wildlife.

Insects and Spiders

Care:

- Keep spiders and insects in a clear glass or plastic container with a secure screen-wire lid.

- Duplicate the animal's natural environment as closely as possible.

- Provide adequate amounts of the proper food.

- Most spiders and insects have a short life span, making a three-day observation period adequate. Release them in the same general area as captured.
- Never keep poisonous insects or spiders in the classroom without the immediate supervision of a trained person.

Handling:

- Many of these organisms are fragile and should not be handled when alive. Large specimens may be handled with care.
- Kill insects and spiders in jars with alcohol vapor or carbon dioxide. Cyanide compounds are quite dangerous and should be avoided.

Protozoans

Bacteria:

- Even though bacteria normally used in public schools are nonpathogenic, handle all cultures as if they were pathogenic (disease-causing bacteria).
- Tape shut all culture plates following inoculation.
- Destroy cultures either chemically or with heat following laboratory exercise.
- Instruct all students in bacteriological techniques and insist the techniques be followed while conducting experiments.

Fungi:

- Use the same procedures with fungi as with bacteria.
- Never allow persons to taste or ingest any of the fungi such as locally collected mushrooms, *Penicillium*, or *Rhizopus*.

Liquid Cultures

Never taste or ingest any liquid protozoan culture.

Preserved Specimens

- When dissecting specimens preserved in formalin, the vapor may cause eye or epidermal irritation or reaction. To avoid this, bathe them in fresh water for 24 hours prior to their use.
- Use scissors for dissecting specimens, not razors or scalpels.

Chemical Hazards

- Handle hot liquids with care.
- Do not taste papers such as pH or litmus or any test solution (Fehling's or Benedict's). Store or prepare papers intended for tasting (such as PTC) under sterile conditions.
- Label the contents of all containers.
- Properly dispose of used containers.
- Provide proper ventilation for experiments using volatile solutions.

Equipment

Be sure to properly treat all equipment used repeatedly by students to reduce and/or remove any possible contaminant or disease agent. Among the types of equipment that require sterilization or proper treatment are stethoscopes, blood pressure equipment, blood testing equipment, safety goggles, thermometers, respiratory apparatus, and pipettes.

PLANTS IN THE LABORATORY

The use of plant life in the classroom is not only educationally sound but is aesthetically pleasing as well. Normally, there are few precautions to be heeded in relation to plants. However, one must be mindful of plants' potential dangers as well as their beauty. Each locale across the state has plants that are native, cultivated, or introduced that present hazards of either a mechanical or chemical nature.

Thorns are the most obvious problem encountered in plants used in the field or classroom situation. Students in both situations should not be allowed to use such plant materials for projectiles or other types of "horseplay." Some species of grasses, such as spear grass and grass burrs possess modified seeds that render them a nuisance and a possible cause of irritation. Most problems associated with plants are of a chemical nature encountered when parts of the plants are ingested or crushed on the skin. Students, especailly the younger ones, should be strongly instructed to never ingest any part of a plant in laboratory exercises, or field studies without a thorough knowledge of that plant. Perhaps the best examples of how problems arise would be the fruits of the tomato and potato; both are eatable, but the foliage of both plants may be fatal. Both of these plants are adapted for human consumption worldwide. Domesticated plants have their associated problems, and with the rise in popularity of house plants, another dimension of concern has arisen.

Extra care must be taken with plants such as dracaenas, dumb cane (Diffenbachia, sp.), and yews to prevent accidental poisoning. Much remains to be learned about the results of ingestion of many plant parts. With the increasing number of desirable mutant strains appearing on the market, the rate of caution in their handling increases.

General Plant-Use Guidelines

Be familiar with the dangerous plants in the area of study. The following guidelines should be observed to ensure the safe use of plants in laboratory investigations:

- Do not put any part of a plant in the mouth.
- Do not rub plant sap or juice into the skin or open wound.
- Do not inhale or expose skin or eyes to the smoke of any burning plant.
- Do not pick unknown cultivated flowers or wildflowers.
- Do not eat food or drink fluids after handling plants without throughly washing and rinsing the hands.
- There are no "safe tests" or other dependable folklore methods for distinguishing non-poisonous from poisonous plants.
- Be sure of possible hypersensitivity of persons handling plants.

Representative Plants: Their Toxic Parts and Symptoms

The list on page 9 of well-known plants illustrates the precautions that should be exercised when working with plants in the laboratory or field. It is not inclusive of all hazardous plants found in the state.

PLANT	TOXIC PART(S)	SYMPTOMS
Hyacinth, Narcissus, Daffodil	Bulbs	Nausea, vomiting, diarrhea. May be fatal.
Oleander	Leaves, branches	Extremely poisonous, affects the heart, produces severe digestive upset and has caused death.
Dieffenbachia (Dumb Cane) Elephant's Ear	All parts	Intense burning and irritation of the mouth and tongue. Death can occur if base of the tongue swells to block air passage of the throat.
Castor Bean	Seeds	Fatal. Single bean seed may kill child; two are near lethal dose for adult.
Mistletoe	Berries	Can be fatal.
Lily of the Valley	Leaves, flowers	Irregular pulse, usually accompanied by digestive upset and mental confusion.
Iris	Underground stems	Severe, but not usually serious, digestive upset.
Rhubarb	Leaf blade	Fatal. Large amounts of raw or cooked leaves can cause convulsions, coma, followed rapidly by death.
Yew	Berries, foliage	Fatal. Foliage more toxic than berries. Death usually sudden without symptoms.
Wild and cultivated cherries	Twigs, foliage	Fatal. Contains a compound that releases cyanide when eaten. Gasping, excitement, and prostration are common symptoms that often appear in minutes.
Buttercup	All parts	Irritant juices may severely injure the digestive system.
Nightshade	All parts, especially the unripe berry	Fatal. Intense digestive disturbances and nervous symptoms.
Poison Hemlock	All parts	Fatal. Resembles a large wild carrot. Used in ancient Greece to kill condemned prisoners.

NOTE: If a student displays suspected plant-caused systemic reaction, the local poison control center should be contacted for advice and recommended procedures to follow until parents are contacted.

FIELD TRIPS

Field trips are an essential part of the science curriculum. One of the most effective ways to study natural phenomena is to observe them in their own peculiar setting. A field trip can be a valuable teaching/learning experience for both teacher and student. However, a poorly planned field trip can be a waste of time and worse than no trip at all. Successful field trips are characterized by well-stated educational objectives, pretrip preparation, and effective follow-up activities and discussion. Also, every precaution should be taken to assure the safety of students and teaching personnel while taking a field trip. The following are general safety guidelines to observe to make field trips safe and effective as teaching strategies:

- Visit the site prior to the actual field trip. The teacher should have a thorough knowledge of the field trip area, including obvious dangers such as poisonous plants, snakes, fall areas, and water and electrical hazards.
- Establish rules for safe conduct prior to the trip and make sure they are observed by all present.
- Inform students of the potential dangers of the area, especially when field trips are to be conducted near deep or rapidly moving water. Never permit poor or nonswimmers in any body of water.
- Dress according to the demands of the terrain and weather.
- Have adequate supervision, teachers and parents, for the class size.
- Use the "buddy" system in which students share responsibility for their partners.
- Take a well-stocked first-aid kit; include a snake-bite kit.
- Be sure that proper consent forms are completed and signed, according to school policy, and turned in to the teacher prior to departure.
- Avoid taking glass containers.
- Include appropriate repellants to protect against mites, ticks, and mosquitoes.
- Weigh the economy of private cars for transportation against the educational benefit and safety of having all students on the same school or private bus.
- If the field trip is to include any potentially hazardous activities, discuss and demonstrate proper safety procedures prior to the trip.
- Students will remain under adult supervision at all times.
- If private land is used for the field trip, obtain the landowner's permission, preferably in writing with a disclaimer of responsibility, prior to work on that land.
- In case of a reptile bite:
  - Determine whether or not the reptile is poisonous.
  - If nonpoisonous, follow guidelines in the first-aid manual dealing with treatment of bites.

- If poisonous, follow the directions in the first-aid manual and seek medical attention at once.

- In case of a poisonous insect bite:

  - Determine the type of insect that inflicted the wound.

  - For most bites and stings, a cold compress applied to the area will bring relief in a short period of time.

  - Should students be hypersensitive to bites or stings, this must be known prior to the trip. They should have medication with them, and if needed it should be administered according to the doctor's directions. Closely observe such an individual. Should medication not be available, get medical attention to the person as quickly as possible. Immediately notify the student's parents.

- Notify the parents of any student involved in a mishap immediately upon return from the trip.

Use of Aquariums in the Laboratory

THE AQUARIUM: A CLASSROOM TEACHING AID

The all-glass type of aquarium is best suited for the classroom because of freedom from corrosive metals and because this type is generally less expensive than other types. The aquarium should be placed in indirect light, not in direct sunlight unless experiments with photosynthesis are being carried out. In such cases, it should be subjected to not more than two hours of sunlight each day. The aquarium offers a living environment for many types of organisms. With a few simple instructions, the students can set up a well-balanced aquarium that will add interest to the laboratory and offer materials for a number of highly interesting experiments. A community aquarium containing a variety of species that are compatible is suggested rather than just one species.

Size of Aquarium

There are many sizes to choose from, but the 5- to 10-gallon size is practical for the classroom.

Water

Pour tap water into open glass or plastic containers and allow it to stand for 24 hours before adding to the aquarium. This permits the water to absorb oxygen from the air and to lose its chlorine, which is harmful to fish.

Sand

Coarse sand may be purchased from a pet shop. Garden or yard sand is contaminated with many types of harmful bacteria and fungi. The sand must be thoroughly washed through a sieve to remove fine particles that will cloud the water. Spread about five cm of sand on the aquarium floor, building the layer higher towards the back and ends where plants will be rooted. This also gives a clear swimming area for the fish as well as permitting debris to collect toward the front for easy cleaning with a siphon or dip tube.

Water plants

There are many types of water plants that may be used; those that give off the most oxygen are Vallisneria, commonly known as tape grass or eelgrass; and Anacharis, also known as elodea. The elodea is the most rapidly growing aquarium plant. Under good conditions, it will grow as much as an inch a day even when uprooted and floating on the water surface. The plants should be taken gently by the roots and pushed into the deeper sand at the back and ends of the aquarium with sand piled up around the roots to anchor them securely. Sea shells or coral should never be used in a fresh-water aquarium as they are harmful to the fish.

Snails

After placing the plants in the aquarium, permit it to stand for one or two days and then place one or two snails in it. If the snails live and appear normal after three or four days, the water is safe for fish.

Fish

A correct number of fish are necessary to obtain a balance in an aquarium. A good rule to follow is to have no more than three medium-sized fish per gallon of water, provided there are plenty of plants to supply oxygen and to remove the carbon dioxide. If more fish are desired, an aerator should be used to keep a steady supply of oxygen entering the water. Another good rule to follow when an aeration pump is not used is one gallon of water for fish.

Water temperature

A temperature range of 68-78°F (22-25°C) is usually satisfactory, although some fish, such as guppies, will reproduce best at a temperature from 75-78°F (23.9-25.5°C). Small heaters with thermostats are available to keep the water temperature constant during cold seasons.

Thermometer

The aquarium should be equipped with a thermometer. Two inexpensive types are available, a floating type and one that can be hooked to the side of the aquarium.

Food

There are a number of prepared foods available at pet shops. Remember that a small guppy is unable to swallow the coarse-sized food needed by larger fish; use fine and medium size food for the small varieties of fish. Fish, like humans, like a change of diet now and then. The best time to feed exotic fish is in the morning; it should be done by the same person each day so the fish will become used to one person and will not become excited at feeding time. Do not feed more than the fish will eat in five minutes. Overfeeding will cause cloudy water and decay. If the fish do not come quickly for their meal, withhold the feeding until they appear hungry. Remove excess food with a dip net after a five-minute feeding period.

Keeping the Aquarium Clean

Fresh-water snails will help keep the aquarium clean because they eat the algae that cling to the glass and plants. One pair of snails is enough to start with, and because most types multiply rapidly, it is necessary to give the offspring away. In an eight-gallon tank, six to eight snails of a small specie such as pond snails are adequate. Use both egg-laying and live-bearing snails to add interest to the aquarium life. Fish droppings and other debris are easily removed with a dip tube or siphon without disturbing the fish or plants. Pumps and filters that operate continuously to remove waste and aerate the water are available at any store where aquarium supplies are sold. Choose a good pump and have it checked for quiet operation. Several types of filters use filtering materials. One model hangs on the outside of the aquarium, and the other type rests on the floor of the aquarium. Both of these are highly efficient in filtering and aerating and operate by means of a small electric pump. The third type of filter is a large, flat, ribbed plastic piece perforated with small holes. It fits the floor of the aquarium with the sand to be placed on top of it. At either end are tubes to attach to the air pump. Debris is pulled from the water into the sand layer where it is trapped, and the aerated water returns through outlet tubes back into circulation. In a well-balanced aquarium, the water need never be changed. Add conditioned water every few days to replace that lost by evaporation and dipping or siphoning of wastes. It is much better not to change all the water. However, if a complete change is necessary, be sure to condition the amount of water needed and establish the same temperature as that in the aquarium. When adding water to the aquarium, place a small piece of paper in the tank and pour the water on it to avoid disturbing the sand, plants, and fish.

Transferring the Fish

When transferring fish, use small dip nets, approximately 7.5 cm x 10 cm in size. When the fish are caught, cover the top of the net with the hand to keep them from flipping out. Never handle fish with dry hands.

Adding Fish to the Aquarium

The water in the container of fish and in the aquarium must be of the same temperature since fish are very sensitive to a sudden change in water temperature. Hold or float the container of fish in the tank until the water on the inside and outside are equal in temperature. Slowly release fish into aquarium after temperatures have equalized.

Covering the Aquarium

If the aquarium is not furnished with a lid, cheesecloth may be used to keep the fish from flipping out and to prevent dust from settling on the water surface.

Other Aquarium Animals

Several types of scavenger fish (catfish) are available to help keep the aquarium clean. They feed on leftover particles of food and on algae that grow on the plants and glass. Small African water frogs, newts, and salamanders are interesting specimens to observe. A small clam, two to four cm in length, may be used to study its inhalant and exhalant siphons. Keep a close watch on all animal life in the aquarium, and quickly remove any lifeless forms as they disintegrate rapidly and will spoil the water.

Care of Fish

Use a balanced food suggested by pet shop personnel. Do not overfeed. Aquatic animals will not suffer if not fed over a weekend since there is ample food left in the aquarium. Pet shop personnel will be glad to give advice concerning a fungus cure for scale fungi, chlorine-removal chemicals for tap water, chemicals for clearing and purifying cloudy water, and preparations for neutralizing acidity of the water.

Care of Plants

Dead leaves should be removed from plants to avoid decay that will spoil the water. If they are provided with a lettuce leaf once or twice a week, snails will not eat the plants. Remove the leaf before decay starts.

Laboratory Safety Practices For Students

- It is your responsibility to always act in a manner that will ensure your safety and the safety of the other members of the class.
- Ask for further instructions whenever you do not understand clearly what you are to do.
- Always wear safety goggles when you are heating, hammering, or using acids or bases.
- Stay away from students who are doing experiments where eye protection is needed.
- Do not handle laboratory equipment without permission.
- Do not use any chemical from an unlabeled container.
- When diluting an acid or base, add the acid or base to the water while stirring.
- Never directly breathe the fumes of chemicals, and never taste chemicals or place them near your eyes.
- Dispose of broken apparatus, used chemicals, or waste in special receptacles.
- Never pour chemicals down the drain.
- Accidental spills must be wiped up immediately with wet paper towels. Notify your teacher if you have a spill.
- Immediately report any accidents or breakage to your teacher, however slight they may be.
- Know where the safety equipment such as fire extinguishers are located in your laboratory.
- When heating a test tube, point it away from yourself and anyone else.
- Never heat materials in a closed container.
- Hot glass and cold glass look the same. THINK before handling.
- Always carry equipment in a safe manner that will not endanger other members of the class.
- Never leave equipment in places that could lead to an accident. Use equipment in authorized areas only.
- Never carry a lighted alcohol burner, and never leave a lighted alcohol burner or bunsen burner unattended.
- All chemicals should be used according to the directions given. Observe all signs, labels, and other directions that recommend caution.
- Provide proper ventilation where volatile solutions are being used and stored.
- Wash your hands thoroughly after handling chemicals.

- Clean and replace all apparatus after using.
- Long hair must be tied back when working in the laboratory.
- Remember, accidents happen mainly because students are unaware of safety rules or deliberately violate them.
- For laboratory safety information, refer to *Safety Practices for Science*, TEA Publication CUO 841 02.

BE A SAFE EXPERIMENTER

Investigations

Scientists At Work

Prelab (To The Teacher)

- This activity provides students with a chance to become familiar with laboratory equipment and its use. It also provides experience in the use of the metric system. Seventh grade students develop high interest levels and positive attitudes when given an opportunity to use laboratory equipment early in the year.

- Set up work stations in the room. Examples of stations and materials needed are given below. Instruct the class in the use of the equipment and the task to be performed at each station. Spend no more than one or two class periods on this instruction.

- Stations 4 and 8 must be set up in triplicate because of the time required for students to do the work of these stations. Other stations that become bottlenecks may also need to be set up in multiples.

- All students should complete work at all stations. Students who complete the stations early should be assigned to help slower groups complete their work. All students may need help with calculations at Stations 6 and 7.

- Students should be encouraged and helped to assure that all complete this activity with a feeling of success.

- Stations:

Station 1
3 different-sized graduated cylinders filled to various levels with colored water. Label the cylinders No. 1, No. 2, and No. 3.

Station 2
2 100-ml graduated cylinders
1 beaker filled with green colored water
1 beaker filled with red colored water
1 Erlenmeyer flask
1 Florence flask

Station 3
1 beaker filled with red colored water
2 large test tubes
2 test tube holders
1 test tube rack

Station 4
Triple-beam balances
9 rubber stoppers to be weighed on the balances
3 different sizes at each balance

Station 5
2 meter sticks
4 different lengths of masking tape stuck on the counter or table

Station 6

3 rectangular objects such as a book, a table top, the bulletin board, etc.

Station 7

2 meter sticks
3 different sized boxes, taped shut

Station 8

3 triple-beam balances
1 beaker filled with salt at each balance
1 box of large filter paper at each balance
1 spatula at each balance
1 Erlenmeyer flask at each balance
1 Florence flask at each balance

Station 9

2 ring stands with burrette clamps
2 Celsius thermometers
1 600 ml beaker filled with water

Station 10

triple-beam balances
1 600 ml beaker filled with water
1 flask
2 graduated cylinders
2 beakers

Lab (To The Student)

OBJECTIVE:

The purpose of this investigation is to practice using laboratory equipment and to use the metric system to measure length, area, volume, and mass.

MATERIALS:

The laboratory equipment

PROCEDURES:

1. Each team will perform the task given for each of the 10 stations listed below.
2. Record the data collected at each station in your notebook.
3. The stations may be done in any order. Always move to the station that is open so time will not be wasted waiting.

Station 1

Determine the volume of liquid in milliliters in each of the graduated cylinders.

Station 2

a. Transfer 35 ml of the green liquid from the beaker to the Erlenmeyer flask.
b. Transfer 185 ml of the red liquid from the beaker to the Florence flask.
c. Find the volume in ml of the green liquid remaining in the beaker.
d. Find the volume in ml of the red liquid remaining in the beaker.
e. Return all materials to their original containers. Leave station clean and exactly as you found it.

Station 3

Each member of your team, in turn, must fill one test tube about half full of the red liquid and transfer the liquid from one tube to the other and back to the beaker without touching the test tubes with his or her hands. When you have done the task, write "Station 3 completed" in your notebook.

Station 4

Use one of the balances and determine the mass in grams of each of the three rubber stoppers. Each team member should practice weighing the stoppers.

Station 5

Measure the length of each of the tape strips and record this length in centimeters, meters, and millimeters.

Station 6

Measure each of the designated objects and determine the surface area of each in square centimeters. To do the calculations, use the formula: area = length x width.

Station 7

Determine the volume of each of the objects in cubic centimeters using the formula: volume = length x width x height.

Station 8

a. Transfer 25.5 grams of the salt from the beaker to the Erlenmeyer flask.
b. Transfer 5.3 grams of the salt from the beaker to the Florence flask.
c. Determine the mass in grams of the salt remaining in the beaker.

Station 9

a. Determine the temperature of the water in the beaker in °C.
b. Determine the temperature of the air in the room in °C.

Station 10

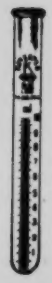
Use whatever equipment necessary and determine the mass of 100 ml of water.

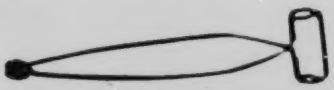
Typical Laboratory Equipment

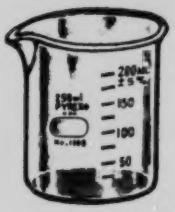
Graduated cylinder

Florence flask

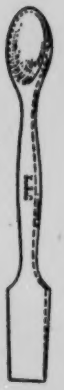
Erlenmeyer flask

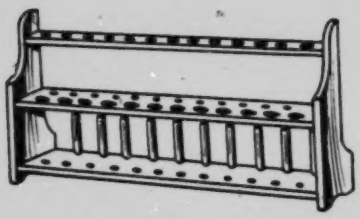

Test tube

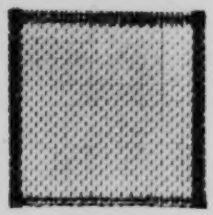

Test tube clamp


Beaker

Funnel


Spatula


Test tube rack


Screen

Bunsen burner

Mortar and pestle

Tripod

Tongs

Ring stand

Thermometer

Medicine dropper

Forceps

Culture dish

Culture slide

Balance, triple-beam

Postlab (To The Teacher)

TEACHER OBJECTIVES:

To help the student become proficient in the use of the metric system in the laboratory and to develop good technique in the use of laboratory equipment.

SUGGESTIONS FOR ACCOMPLISHING THE OBJECTIVE:

1. Review each station before dismantling. Demonstrate the common mistakes the students made and then show the correct method.
2. Do any calculations on the chalkboard while the students check their own work.
3. Give the names of the different metric units and emphasize the units most commonly used.
4. Introduce conversion of metric units from one to another by use of the decimal.

Using a Scientific Method To Solve A Problem

Prelab (To The Teacher)

- Label two Erlenmeyer flasks A and B. Use small flasks to conserve liquid.
- Half fill and stopper Flask A. Flask B should be filled to the top with no air below the stopper.
- Prepare liquid for flasks as follows:
  1000 ml water
  10 g sodium hydroxide
  10 g glucose
  1 ml of 1 percent methylene blue
- Prepare a fresh solution each day.
- Add more 1 percent methylene blue (several drops) to the flasks during the day if color formation is weak.
- The solution will turn blue when first prepared. Allow it to sit until it turns colorless.
- When the solution is poured into the flasks, blue may appear. Wait several minutes and give the students a colorless solution.
- Caution students to keep a thumb on the stoppers whenever they shake them.

Using A Scientific Method To Solve A Problem

Lab (To The Student)

OBJECTIVE:

The purpose of this investigation is to make observations and record accurate data.

MATERIALS:

2 Erlenmeyer flasks containing liquid
2 stoppers (to fit flasks)
clock or watch with second hand
beaker

PROCEDURES:

1. Observe the two flasks. Do not remove the stoppers and do not shake the contents.
2. Record as many similarities or differences between the two flasks as you can in Data Table 1.
   a. Do both flasks appear to contain the same liquid?
   b. Do both flasks have the same amount of liquid?
   c. What gas may be in the top of Flask A that is not in Flask B?

DATA TABLE 1

Similarities	Differences

3. With thumb on stopper, shake each flask once with an up and down motion. Observe each flask.
4. Record as many similarities and differences as you can in Data Table 2.
   a. As a result of shaking, could Flasks A and B contain different liquids?
   b. Explain why it is possible that the liquids in both flasks could be the same and that the space above the liquid in Flask A could be responsible for any change that may have occurred.

DATA TABLE 2

Similarities	Differences

5. Remove the stopper from Flask B and pour out half of the liquid into a beaker. Replace the stopper.
6. Shake both flasks once. Observe both flasks.
7. Record as many similarities and differences as you can in Data Table 3.
   a. Infer why both flasks appear to contain the same liquid.
   b. What may have been added to Flask B that was not present before?

DATA TABLE 3

Similarities	Differences

8. Shake each flask once. Record the amount of time in seconds it takes for each liquid to return to its original condition in Data Table 4.
9. Shake each flask twice. Again record the amount of time in seconds it takes for the liquids to return to their original conditions in Data Table 4.
10. Shake each flask three times. Again record the amount of time in seconds it takes for the liquids to return to their original conditions in Data Table 4.
    a. Describe the behavior of the two liquids after: one shake, two shakes, and three shakes.

DATA TABLE 4

Time in seconds to return to original condition			
	1 shake	2 shakes	3 shakes
Flask A			
Flask B			

11. Repeat procedures through Procedure 10 two more times, and record the results in Data Table 5. Data Table 4 will show results of Trial 1.
    a. Explain how three trials give better evidence than one that the liquids are behaving in a similar or a different manner?

DATA TABLE 5

Time in seconds to return to original condition

	1 shake	2 shakes	3 shakes
Trial	1 2 3	1 2 3	1 2 3
Flask A			
Flask B			

12. Remove the stoppers from both flasks for one minute.
13. Replace the stoppers and shake each flask once. Record any similarities or differences you observe in Data Table 6.
    a. Explain how the removal of the stoppers may cause differences in the manner in which the liquids behave.
    b. What may have entered the flasks while they were open?

DATA TABLE 6

Similarities	Differences

14. Answer the following questions on clean notebook paper.
    a. On the basis of your first observation, could you decide if both flasks contain the same liquid?
    b. After Procedure 3, could you decide if both flasks contain the same liquid?
    c. Did you ever suspect that Flasks A and B both contained the same liquid?
    d. Do Procedures 8, 9, 10, 11, 12, and 13 support the conclusion that the liquids are the same?
    e. In addition to the liquid itself, what seems to be needed for the change to occur in the liquid?
    f. Which procedures support your answer to Question E?

Using A Scientific Method To Solve A Problem

Postlab (To The Teacher)

TEACHER OBJECTIVES:

- To help the students perform an investigation using the scientific method.
- To help the students make observations and record data.

SUGGESTIONS FOR ACCOMPLISHING THE OBJECTIVES:

1. Have students write a hypothesis that explains each of the following:
   a. The liquid in Flask B did not change when the flask was filled completely with the liquid.
      Why?
   b. The liquid in Flask B changed when the flask was only half filled.
      Why?
   c. It is important that shaking occur in both Flasks A and B.
      Why?
   d. The liquids in Flask A and B would take longer to change back to their original color with more shaking.
      Why?
2. Discuss with the students the steps they used in the scientific method.
3. Have the students explain each of the following in their own words:
   - observation
   - experimentation
   - data
   - trials
   - interpretation
   - hypothesis
   - scientific method

ANSWERS TO QUESTIONS IN PROCEDURE 14:

a. Answers will vary.
b. No. Contents would seem different because of color change in one flask.
c. No. No reason to.
d. Procedures 8 through 13 indicate that the liquids behave in a similar manner.
e. For gas to be present in one of the flasks.
f. Procedures 5 and 6, when one-half of the liquid was poured into the beaker from Flask B and the flasks were shaken once.

An Introduction To The Compound Microscope

Prelab (To The Teacher)

- This activity should provide your students with an opportunity to become familiar with a compound microscope, its parts, basic movements, and the need to respect it as an expensive instrument.
- Check all of your microscopes prior to allowing students to handle them, ensuring that the instruments are in proper working order.
- Have ample microscopes available so that each individual student will have first-hand contact and experiences with the instrument.
- The microscopes should all have dust covers. If original covers are missing, replace them with one-gallon freezer bags. Instruct your students in the need for and use of a dust cover.
- It is preferable to have students use the same scope on each occasion so as to improve their skills in using the instrument. Assigning students to a scope aids in this process and helps develop responsibility.

An Introduction To The Compound Microscope

Lab (To The Student)

OBJECTIVE:

The purpose of this investigation is to learn the parts of the microscope and how to use and care for it correctly.

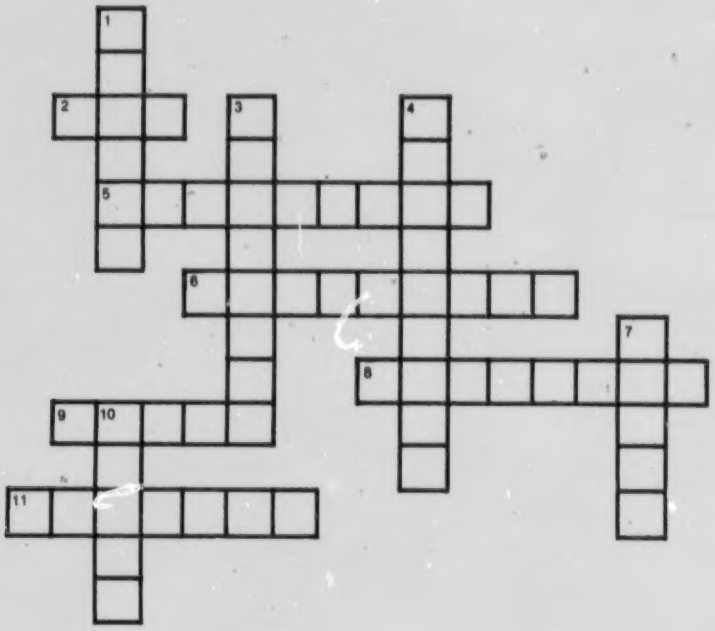
MATERIALS:

microscope (with dust cover)
lens paper
study sheet "Parts of a Microscope"
unlabeled drawing of a microscope

PROCEDURES:

1. The microscope is a valuable tool in the study of life science. It is an expensive instrument that should be used and cared for correctly. The microscope should always be carried with both hands. Place one hand on the arm of the microscope. Keep the microscope in an upright position and level when carrying it. When placing the microscope on a desk or table, do it carefully. Make sure there is a flat, clear surface for the microscope. Carry a microscope, as instructed, to your desk.
2. The eyepiece should not be removed from the body tube.
3. Any liquid spilled on the stage should be wiped off immediately.
4. When putting the microscope away, be sure the low power objective is in line with the eyepiece. The tube should be in the complete downward position. Cover the microscope.
5. Use the study sheet, "Parts of a Microscope," to label the drawing of a microscope.
6. The lenses and mirrors should always be clean. With a new piece of lens paper, gently wipe the lenses and mirror of the microscope. If this does not clean them, ask for help. Lens paper is the only item that should touch a lens or mirror.
7. Familiarize yourself with each of the 15 terms found on the study sheet "Parts of a Microscope."
8. Label each of the parts of the microscope shown on the drawing, using the terms you have just learned.
9. Upon completing your work, store your microscope in its proper place with its dust cover.

10. Complete this crossword puzzle to review the parts of the microscope.



ACROSS

2. handle of a microscope
5. lens on a revolving nosepiece
6. light control
8. type of microscope that does not use light
9. object upon which a specimen is placed
11. to enlarge

DOWN

1. reflect light
3. lens you look through
4. thin piece of glass used in preparing a slide
7. bring into view
10. in the dark without it

11. Answer the following questions in writing on clean notebook paper.
    a. Why should a microscope be carried with both hands?
    b. Why should a microscope be kept level when carried and be kept flat on the desk?
    c. What should always be used to clean a microscope lens?
    d. What would happen if a finger or eyelash touched the lens or mirror?
    e. What are the two types of adjustments on a microscope?

Parts Of A Microscope

Study Sheet

1. **Eyepiece**—the removable cylinder in the top of the microscope, containing one set of lenses. Magnification is marked on the eyepiece (example: 10X).

2. **Body tube**—a hollow cylinder that supports the eyepiece.

3. **Revolving nosepiece**—circular piece at the lower end of the body tube containing one or more objective lens.

4. **Objectives**—one or more small hollow cylinders attached to the revolving nosepiece containing magnifying lens (example: 10X or 40X).

5. **Low power objective**—the shortest objective. It magnifies an amount indicated on the side of the objective (example: 10X).

6. **High power objective**—the longest objective. The amount of magnification is found on the side of the objective (example: 40X).

7. **Stage**—A flat platform that a slide is placed on for observation. A round hole in the center of the stage permits light to pass up from below.

8. **Stage clips**—a pair of long, flat springs mounted on the stage to hold slides in place.

9. **Diaphragm**—a disk beneath the stage with different-sized holes. The diaphragm regulates the amount of light that passes upward through the microscope.

10. **Base**—the flat bottom support of the microscope.

11. **Mirror**—a circular attachment at the base of the moveable arm. The mirror is used to reflect light upward through the diaphragm, stage, objective, tube, and eyepiece to the eye.

12. **Arm**—the curved part of the microscope behind the objectives, connecting the base and tube.

13. **Inclination joint**—a moveable joint located where the arm and base join. This joint allows the microscope to be tilted back.

14. **Coarse adjustment knob**—the largest rotating knob on the side of the microscope that raises and lowers the body tube or the stage.

15. **Fine adjustment knob**—the smallest rotating knob used for sharp focus after the object has been brought into rough focus with the coarse adjustment knob. The fine adjustment knob raises and lowers the body tube or the stage.

An Introduction To The Compound Microscope

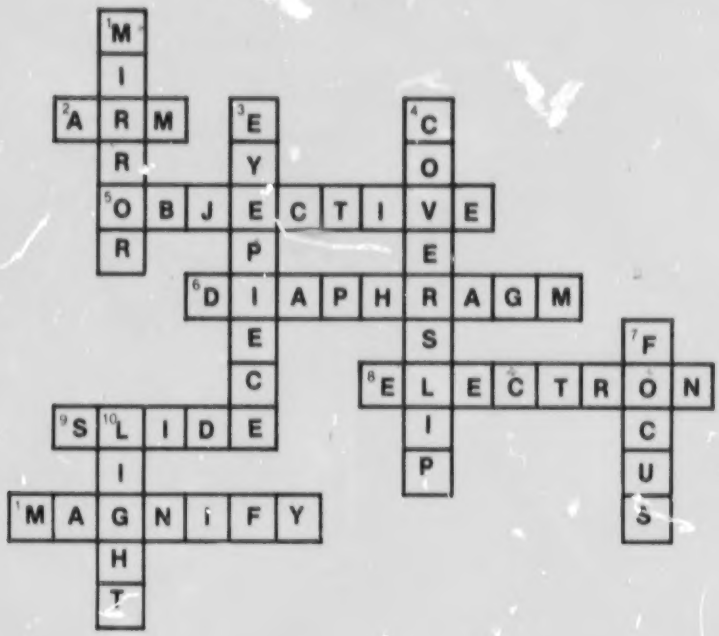
Postlab (To The Teacher)

TEACHER OBJECTIVES:

- To help students identify the parts of the microscope and their functions.
- To have students complete a crossword puzzle to review the parts of the microscope.

SUGGESTIONS FOR ACCOMPLISHING THE OBJECTIVES:

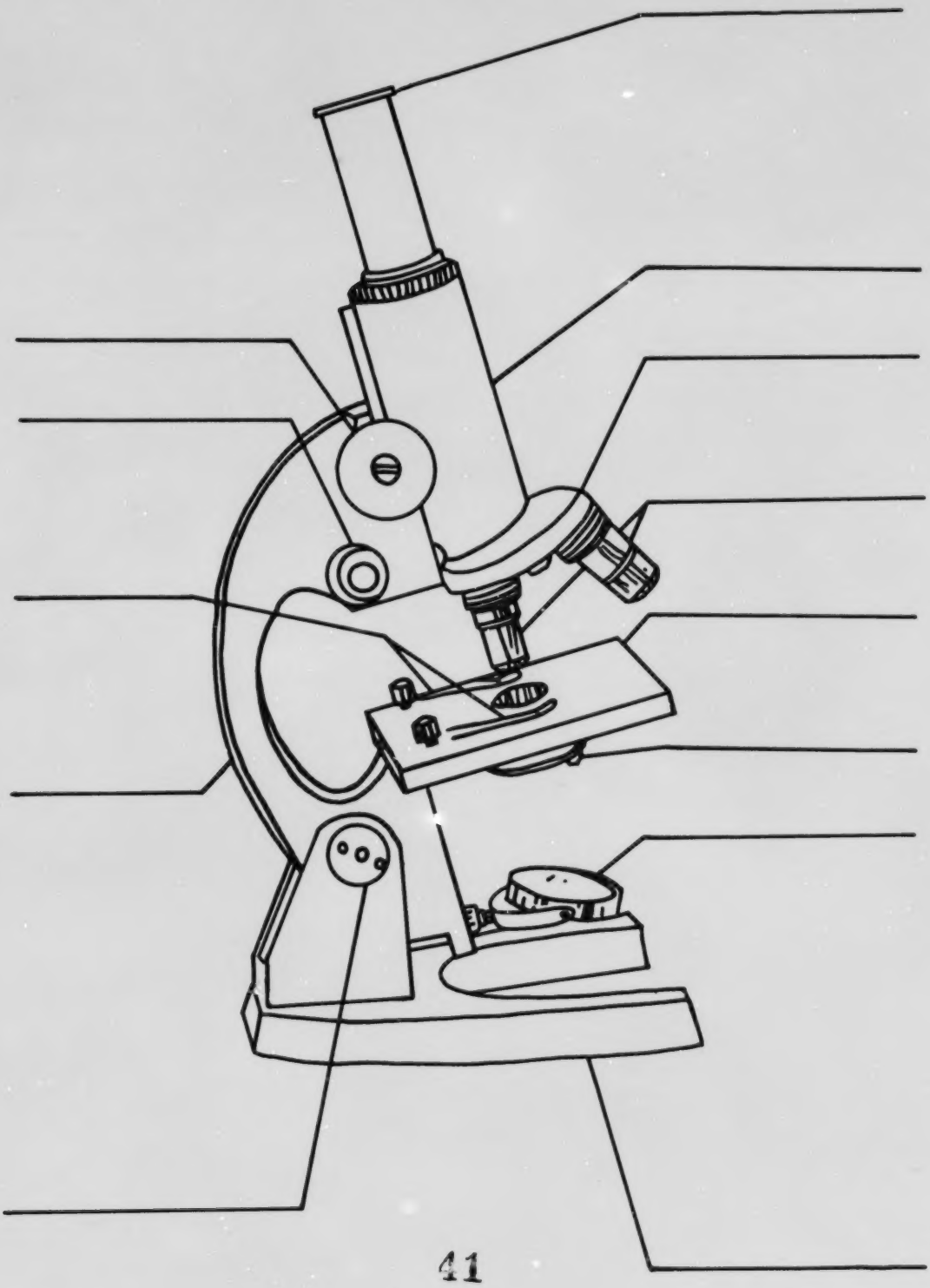
1. Discuss and stress safety and care in handling the microscope.
2. Answers to crossword puzzle.



ANSWERS TO QUESTIONS IN PROCEDURE 11:

a. A microscope should be carried with both hands because there is less chance of dropping it.
b. A microscope should be kept level because there is less chance of the eyepiece falling out and of damaging the microscope by tipping it over.
c. A microscope lens should only be cleaned with lens paper.
d. If a finger or eyelash touches the lens or mirror, oil and dirt will smear them and interfere with viewing.
e. The two types of adjustments on a microscope are the coarse adjustment and fine adjustment.

Compound Microscope



41

Using A Compound Microscope

Prelab (To The Teacher)

- When students draw the sketch of the letter "e," it should be upside down.
- Make sure students know the difference between the low power objective and the high power objective.
- Make sure students know the difference between the coarse adjustment knob and the fine adjustment knob.
- Make sure students understand why the objective lens should not touch the slide.

Using A Compound Microscope

Lab (To The Student)

OBJECTIVE:

The purpose of this investigation is to learn the proper use of the microscope and to prepare a slide for viewing.

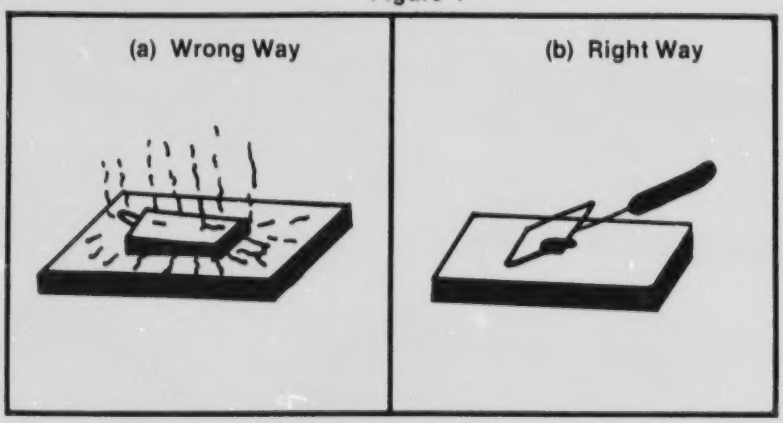
MATERIALS:

microscope
slide
cover slip
classified ad page of a newspaper
dropper
paper towels
scissors
water

PROCEDURES:

1. Materials to be viewed under a microscope are placed on the center of slides and covered with a small piece of glass or plastic called a cover slip. Get a slide and a cover slip and clean both well.
2. Cut a small letter "e" from the classified ad page of a newspaper. Place the "e" in the center of your clean slide.
3. Using the dropper, place a drop of water on the slide. If the letter moves, move it back to its right-side-up position.
4. Slowly and carefully lower the cover slip onto the angle. If the cover slip is dropped on the slide, air bubbles will be trapped. (See Figure 1.)

Figure 1



5. Place the slide on the stage of the microscope to view it. Slip the stage clips over the ends of the slide.
6. Prepare the microscope for viewing by turning the nosepiece until the low-power objective snaps in place. Slides should always be examined under low power first.
7. Looking at the microscope from the side, use the coarse adjustment to lower the body tube or raise the stage. Never look through the eyepiece while lowering the body tube or raising the stage. Keep lowering the tube or raising the stage until it is almost touching the slide.
8. While looking through the eyepiece, use the coarse adjustment to slowly raise the body tube or lower the stage until the "e" can be seen clearly. Now use the fine adjustment to bring the "e" into sharp focus. Draw a sketch of what you see.
9. Look through the eyepiece and move the slide slightly to the left. Observe which way the "e" moves. Now observe what happens when the slide is moved to the right, forward, and backward.
10. Now turn the nosepiece until the high power objective snaps in place. Do not let the objective touch the slide. Look through the eyepiece and center the "e" in the area seen.
11. Under the high power objective, little or no adjustment is necessary. If adjustment is necessary, use the fine adjustment to focus on the "e." Never use the coarse adjustment to focus on high power.
12. Take the slide off the stage. Take the cover slip off the slide. Wash the slide and cover slip, and gently blot dry.
13. Put the low-power objective in place, cover the microscope, and return the microscope to its proper place.
14. Answer the following questions on clean notebook paper.
    a. What is the function of a slide?
    b. How is the slide held in place on the stage?
    c. With which power should you always start your examination?
    d. Why should you always watch from the side when lowering the body tube or raising the stage?
    e. Give two reasons for not allowing the objective to touch the slide.
    f. Which way does the "e" move when you move the slide to the left? The right? Forward? Backward?
    g. Why should you use the fine adjustment when focusing on high power?

Using A Compound Microscope

Postlab (To The Teacher)

OBJECTIVES:

- To help the students learn to observe a specimen using the microscope.
- To help the students learn the proper method for focusing with the microscope.

SUGGESTIONS FOR ACCOMPLISHING THE OBJECTIVES:

1. Have the students identify the low and high power objectives and the coarse and fine adjustment knobs.
2. Discuss with the students the proper method for focusing.
3. Discuss these common causes of microscope troubles with your students:
   a. Is the mirror reflecting enough light?
   b. Is your high or low power objective locked into place?
   c. Is the variable focus condenser open?
   d. Has the lens been cleaned?
   e. Was the low power used first?
   f. Is the specimen centered under the objective?
   g. Did you follow directions accurately?

ANSWERS TO QUESTIONS IN PROCEDURE 14:

a. The slide holds the specimen being observed.
b. The slide is held in place by the stage clips.
c. You should always start your examination on low power.
d. You should watch from the side so that the objective lens does not hit the slide.
e. The objective lens should not touch the slide because it could damage the objective and/or the slide.
f. When you move the slide to the left, the "e" moves to the right. The subject "e" will always appear to move in the opposite direction of the slide.
g. You should use the fine adjustment because the object has already been focused on low power, and the fine adjustment will move the objective only slightly.

Preparing Temporary Slides

Prelab (To The Teacher)

- This activity provides your students with an opportunity to improve their proficiency in using the microscope.
- Inform your students of the need for clean slides in their work as this affects their observations.
- Instruct your students to look for depth in their slide preparations, as all objects viewed have three-dimensional characteristics. The threads used in this investigation will aid in this process.
- You may want to demonstrate the procedure for making a wet mount slide by preparing a sample slide for the whole class using an overhead projector and wall screen.
- Check on students frequently to make sure they are looking at the correct thing.

Preparing Temporary Slides

Lab (To The Student)

OBJECTIVE:

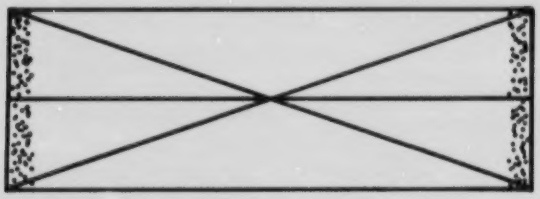
The purpose of this investigation is to learn how to prepare wet and dry mount slides.

MATERIALS:

microscope
slide
water
paper towels
cover slip
dropper
tissue paper
thread (three different colors)
dissecting needle or toothpick
metric ruler
scissors
tape

PROCEDURES:

1. Clean and dry a slide. Make fingerprints on the slide by touching the flat surfaces with the fingers. Examine the fingerprints under low and high power.
2. There are two types of slides that can be used in the study of life science. One is a dry mount and the other is a wet mount. If no liquid is used to prepare the slide, it is called a dry mount. If the object to be viewed is placed in water or some other liquid, it is called a wet mount.
3. Clean and dry a slide. Make sure the slide is always handled by the edges.
4. Cut a piece of thread seven cm long from each of three spools.
5. Tape the three threads in a crisscross pattern on the clean slide (see drawing).



6. Examine the slide under the microscope. Focus the microscope where the three threads cross.
7. Focus the microscope on each of the three threads individually. Have the teacher check your work as each thread comes into focus.
8. Remove the thread from the slide. Clean and dry the slide and a cover slip.
9. Cut out a small piece of tissue paper about one cm by one cm.
10. Put a drop of water on the clean slide and place the piece of tissue paper on the drop of water.
11. Cover the piece of tissue paper with the cover slip.
12. An air bubble, when seen under a microscope, looks like a circle with black edges and a clear center. If air bubbles get under the cover slip, try to push them out by gently pressing or tapping on the cover slip with a dissecting needle or pencil eraser.
13. Use slides and cover slips free of scratches.
14. Examine the slide under the microscope. Draw what you see with low and high power.
15. Prepare and examine temporary slides of some other materials, such as colored magazine paper, hair, dust, or cotton. Draw sketches of the materials you examine.
16. Answer the following questions on clean notebook paper.
    a. Why should a slide be held by the edges?
    b. Why should slides and cover slips be carefully cleaned before use?
    c. Why was it not possible to focus on all three threads at the same time?
    d. What could happen if the cover slip is dropped onto the slide?
    e. Why should you make sure there are no air bubbles under the cover slip?
    f. Why are these slides called temporary slides?

Postlab (To The Teacher)

TEACHER OBJECTIVES:

- To help students learn the correct procedure for preparing temporary slides.
- To help students identify the difference between wet and dry mounts.

SUGGESTIONS FOR ACCOMPLISHING THE OBJECTIVES:

1. Discuss the difference between wet and dry mounts.
2. Make a slide with air bubbles in it and show it to the students using a bioscope, if available, or microscope.
3. Introduce permanent mount slides. Discuss what they are and how they are made.

ANSWERS TO QUESTIONS IN PROCEDURE 16:

a. Slides should be held by the edges to prevent fingerprints which interfere with observing.
b. Slides and cover slips should be carefully cleaned because even if they look clean, they may have fingerprints or other dirt on them.
c. It is not usually possible to focus on all three threads at the same time because each thread is usually a different distance from the lens.
d. If the cover slip is dropped on the slide, air bubbles may be trapped.
e. There should be no air bubbles under the cover slip because the air bubbles will interfere with observing.
f. These slides are called temporary slides because they are used only for a short time and then they are cleaned to prepare another object for viewing.

Cells: An Investigation

Prelab (To The Teacher)

- Students should have been previously instructed in the use of the microscope and in the preparation of a wet slide.
- A discussion of cells is not necessary. The purpose of the investigation is for students to discover different types of cells and conclude that living things are made of cells.
- An explanation of why the stains are used is not necessary. The students will discover that more can be seen when slides are stained.
- Microscopes or drawings should be checked often to make sure the students are seeing what they should.
- Seventh graders may complain "I can't draw," but most will make acceptable drawings.
- The elodea plant must be ordered prior to the beginning of this investigation. The elodea may be purchased, if necesary, from stores that sell fish and aquarium supplies.
- The salt solution (1 g salt in 100 ml water) used in Procedure 6 will cause water to be drawn from the plant cells and the cell to shrink. The cell membrane will pull away from the cell wall and allow the students to see that these structures are separate.
- In advance of the lab, discuss a drawing and labeling technique that you find acceptable for your students. Then they will know what is expected in their drawings.

Cells: An Investigation

Lab (To The Student)

OBJECTIVE:

The purpose of this investigation is to observe cells, identify different types of cells, hypothesize about relationships between cells and organisms, identify the main parts of cells, and distinguish between plant and animal cells.

MATERIALS:

microscope
slides and cover slips
droppers
scissors
forceps
tissue paper
flat toothpicks
Iodine potassium iodide solution (I-KI)
Methylene blue stains
salt water solution (1 g salt in 100 ml water)
generalized drawing of a plant cell
onion skin
elodea

PROCEDURES:

1. Obtain a one-centimeter square of onion skin and place it on a slide. Place a drop or two of water on the onion skin and drop a cover slip into place over the onion skin square. Place the slide on the microscope stage. Using low power, bring the onion skin into focus. Draw exactly what is seen on clean paper, and label the drawing "Unstained Onion Skin."
2. Using the same onion skin slide prepared in Procedure 1, drop two or three drops of the I-KI solution on one end of onion skin slide at the edge of the cover slip and touch the opposite edge of the cover slip with a corner of the tissue paper. The tissue paper will absorb the water from under the cover slip and pull the I-KI solution under the cover slip to replace the water. When the tissue paper changes from white to blue or purple, the slide is ready to observe again. Using low power, focus the microscope on the edge of the onion skin. Draw exactly what is seen, and label the drawing "Stained Onion Skin." Switch the microscope to high power, and focus on one cell. Draw what is seen, and label this drawing "Stained Onion Skin— High Power." Clean the slide and cover slip, and return all materials that have been used to the proper places.
3. Obtain from the teacher a sterile flat toothpick, a clean slide, and a cover slip. Put one or two drops of I-KI solution in the middle of the slide. Gently scrape the inside of your cheek with the large end of the toothpick. Add scrapings to the drops of I-KI solution. Drop the cover slip in place over the solution on the slide. Observe the slide with the microscope and draw what is seen. Label the drawing "Stained Animal Cells—Low Power." Switch the microscope to high power and again observe the slide. Draw what is seen and label the drawing "Stained Animal Cells—High Power."
4. Select a healthy leaf from a sprig of elodea, and cut a one-cm piece from the tip end. Place the piece of leaf on a slide and drop several drops of water on it. Cover with a cover slip. Observe the slide with a microscope using low power. Draw one or two cells exactly as they are seen. Label the drawing "Unstained Elodea Leaf—Low Power." Observe the slide using high power, and draw the same cells exactly as they are seen. Label the drawing "Unstained Elodea Leaf—High Power."

5. Using the method used in Procedure 2 to stain the onion skin with I-KI, stain the elodea slide with methylene blue. Observe using low power and high power. Make drawings and label them.
6. Make another elodea slide as in Procedure 4. Apply the salt solution to the slide in the same way stains were applied in Procedures 2 and 4. Observe the slide using low power, and draw what is seen. Label this drawing "Elodea with Salt Solution."
7. Answer the questions below on clean notebook paper.
   a. What do you think the unstained onion skin looks like?
   b. What are plants and animals made of?
   c. Compare the unstained and stained onion skin drawings. Why do scientists stain slides?
   d. What are the main differences between plant and animal cells?
   e. How are plant and animal cells alike?
   f. Why do you think cells have parts?

Postlab (To The Teacher)

TEACHER OBJECTIVES:

- To provide an opportunity for students to develop skills in the use of the microscope, making and staining slides and recording observations by sketching what is seen through the microscope.
- To help the students to distinguish between plant and animal cells.
- To lead the students to develop the hypothesis that plants and animals are made of cells.
- To allow the students to identify the main parts of cells from their own observations of cells.

SUGGESTIONS FOR ACCOMPLISHING THE OBJECTIVES:

1. Allow the students to make slides, stain slides, and focus the microscope on their own as much as possible. Make suggestions and help individuals as needed.
2. When observing a student's slide, discuss what is seen on the slide using the proper terms. Point out structures and differences between stained and unstained slides.
3. This investigation is an introduction to cells. While functions of parts of cells should be noted and discussed, it is not necessary to go into great detail at this time.
4. The student's drawing and labeling, along with an assessment of laboratory technique, may be used for evaluation.

ANSWERS TO QUESTIONS IN PROCEDURE 7:

a. Answers will vary. Generally the cell looks like an oblong or rectangular-shaped box.
b. Plants and animals are made of cells.
c. In comparing, the stained cells have features that are more easily observable with the eye. This is why scientists stain slide materials.
d. The main difference between plant and animal cells is their observable structures. Plant cells appear to have thick outer borders.
e. Plant and animal cells are alike in that they both contain a nucleus, cytoplasm, and outer covering.
f. Cells have parts so that they can perform various necessary life functions (example: digestion, respiration, and reproduction).

Water Organisms In A Food Pyramid

Prelab (To The Teacher)

- This activity allows students to learn how organisms are dependent on each other for life.
- When collecting pond water, make sure that mud or bottom ooze are collected along with surface water. Allow the pond water to settle before using.
- Scrapings from the side of the fish tank may be used for pond water.
- The protists are single celled, and the animal kingdom are multicellular. The largest number of organisms in the pond water are from the plant kingdom.
- Animals have the ability to move; plants are green and cannot move. The euglena has traits common to both kingdoms. It has chloroplasts, and it moves.
- After the first week, add 10 ml of rotten bean juice twice a week. Prepare the bean juice by placing 10 bean seeds in a baby food jar filled with water. Place the lid on tightly, and soak for several days.

Water Organisms In A Food Pyramid

Lab (To The Student)

OBJECTIVE:

The purpose of this investigation is to observe various organisms in a grass-water mixture.

MATERIALS:

clean jars with loose fitting covers
tap water
microscope
2 microscope slides
25 ml healthy ditch or pond water
Bunsen burner with ring stand
dried grass
medicine dropper
2 cover slips
600 ml beaker

PROCEDURES:

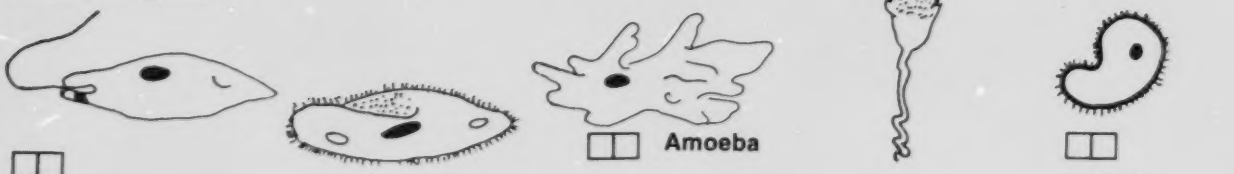
1. Study the drawings of water organisms below, and become familiar with some of the types of organisms to be found.
2. Wash the jars and beakers, and rinse three times.
3. Fill the beaker with 300 ml of water, and add the dried grass. Bring the contents of the beaker to a boil.
4. Let the boiled mixture cool to room temperature and add 25 ml healthy pond or ditch water. Place the mixture in a jar with a loosely fitting lid.
5. Place the jar in a place where it will not be disturbed, out of direct sunlight, and away from a heat source.
6. Do not disturb the jar for four days.
7. On the fourth day, take a sample of water from near the top at the edge of the jar.
8. Place the sample on the slide, and cover with a cover slip.
9. Examine through the microscope.
10. Draw any organisms seen on clean paper, and estimate the numbers present in the jar.
11. Take a sample of water from the bottom of the jar.
12. Draw any organisms seen, and estimate the numbers present in the jar.
13. Repeat Procedures 7 through 12 every day for two weeks.
14. Label all drawings as to whether they were found on the surface (S) and/or bottom (B) of the jar.

Ex:

Surface	S	
Bottom		B
Both	S	B

WATER ORGANISMS

Protista Kingdom



☐☐ **Euglena (green)**

☐☐ **Paramecium**

☐☐ **Amoeba**

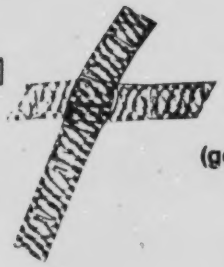
☐☐ **Vorticella**

☐☐ **Colpoda**
most common protist

Plant Kingdom

Oscillatoria (blue-green) ☐☐

Spirogyra ☐☐



Diatoms (golden brown) ☐☐

Variety of shapes are common.

Animal Kingdom

☐☐ Rotifer

☐☐ Cyclops

☐☐ Daphnia

☐☐ Nematode Worm

---

15. Answer the following questions on clean notebook paper.
    a. How did the organisms get into the jar in the first place?
    b. Name the animals you observed, and note if they were obtained on the surface, bottom, or both.
    c. What happened to the large organisms?
    d. What type of organisms will appear in the jar first?
    e. What do each of the organisms eat?

ANSWERS TO THE QUESTIONS IN PROCEDURE 15:

a. Two possible sources of organisms are the ditch water and the added bean juice.
b. Answers will vary.
c. The large organisms disappeared because their food source disappeared, because they were preyed upon by others, or because they were decomposed.
d. The protists will appear first in the jar.
e. The organisms eat each other as a food source.

Water Organisms In A Food Pyramid

Postlab (To The Teacher)

TEACHER OBJECTIVES:

To help the student identify at least three different organisms using the drawings on pages 50-51 as a guide.

SUGGESTIONS FOR ACCOMPLISHING THE OBJECTIVES:

1. Have the students look for color and movement. Procedure 14 tells colors and types of movement to expect.
2. After the students have sketched some organisms, help them to determine which organisms they observed.
3. Answers to Procedure 14 will vary, but the protists will be seen first. Below is a list of the organisms pictured in Procedure 14 and the levels at which they would be found in the mixture.

WATER ORGANISMS

Organism	Surface	Bottom	Both Areas
Euglena	X		
Paramecium	X		
Amoeba		X	
Vorticella		X	
Colpoda			X
Oscillatoria		X	
Spirogyra	X		
Diatoms		X	
Rotifer			X
Cyclops			X
Daphnia			X
Nematode Worm			X

Organisms In The Soil

Prelab (To The Teacher)

- In this activity the student will collect soil organisms, classify their types and infer different types of organisms that might be found in different habitats.
- The soil sample block should be collected by small organized groups of students.
- Plan to have books available for your students to assist with identifying animal types collected.
- The soil samples should be taken from a moist grassy area that does not receive a lot of traffic. (Example: from next to the building or the edge of the football field.)
- Advise the students to measure 15 cm^3 by measuring 15 cm^2 and then measuring 15 cm deep.

Organisms In The Soil

Lab (To The Student)

OBJECTIVE:

The purpose of this investigation is to collect and classify organisms found in the soil samples.

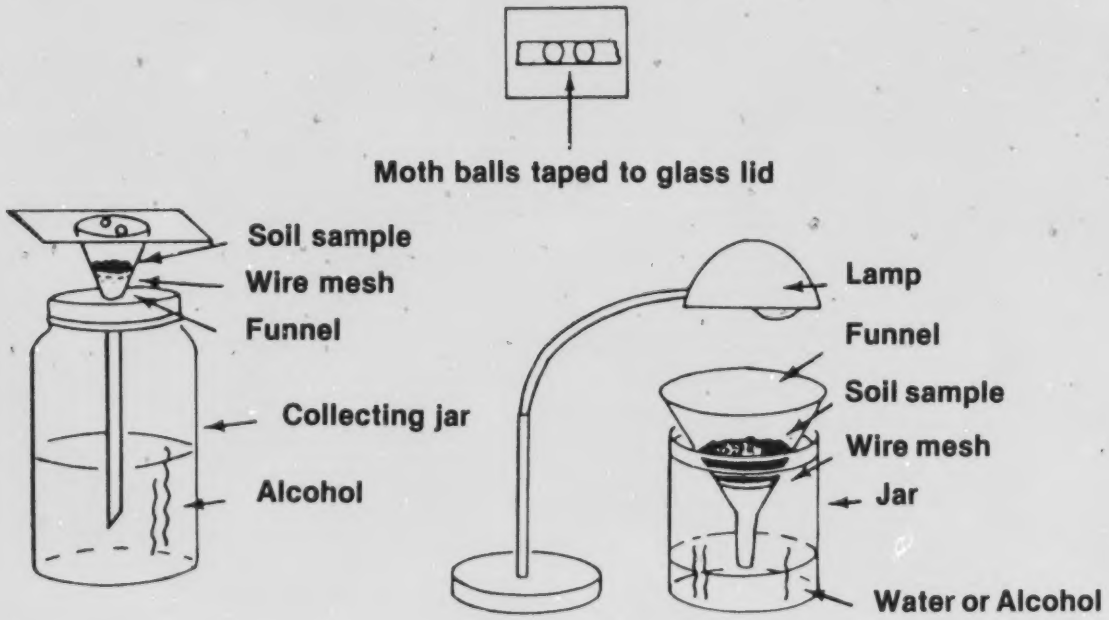
MATERIALS:

1 jar
1 funnel to fit jar
1 course, wire-mesh screen to fit halfway into the funnel
water or small amount of 70 percent alcohol
2 or 3 mothballs and tape (if lid is used instead of lamp)
hand lens, or microscope
sieve
reference books on insects and soil

PROCEDURES:

1. On the day needed, collect 10 cm^3 soil samples from various environments. Label each sample.
2. Describe the soil sample as to dry or moist, coarse or fine, etc.
3. Examine the soil samples for organisms.
4. Prepare and use the collecting apparatus as shown in the drawings.
5. Identify and count each species collected.

Collecting Apparatus



TULLGREN FUNNEL **BERLESE FUNNEL**

6. Report your findings in the chart below.

Location of Sample **Date** **Time**

Name or drawing of organism	Number found

7. Answer the questions below on clean notebook paper.
   a. Which animal appeared to be most abundant in your sample?
   b. Compare your results with another group's results. List those animals that were present in both samples.
   c. Did all of you find the same types of organisms? Explain.
   d. Do you think location made a difference in the numbers and types of organisms found? Explain.
   e. Should the time of day affect the type and amount of organisms collected in the same location?

Postlab (To The Teacher)

TEACHER OBJECTIVES:

To help the students identify the populations in a community of organisms.

SUGGESTIONS FOR ACCOMPLISHING THE OBJECTIVES:

1. Have the students compare their findings with their classmates and with the reference books on insects and soil.
2. Have the students sketch the organisms they observe.

ANSWERS TO QUESTIONS IN PROCEDURE 7:

a. Answers will vary depending on locality surveyed.
b. Answers will vary, but some species should show up as being similar in abundance or types.
c. Answers will vary, but similarities in results will occur.
d. Generally yes. Like locations should produce similar results and contrasting locations will produce variations and differences.
e. Results will vary due to different habits of organisms.

A Population

Prelab (To The Teacher)

- All of the plants in a specified area make up a community of plants.
- The number of individual plants of one species in a specified area is a population.
- The one-square meter areas assigned each team of students may be selected by tossing a small pebble or other object into the large square and using the pebble or object as a center marker for the student's one-square meter sample.
- The prediction of the number of individuals in the population is made by finding the average number of plants in the sample squares and multiplying by the total number of one-meter squares in the entire plot.
- Students should be allowed to try to determine their predictions from the data before being told how to make the calculations.
- Survey the school grounds or other potential study areas ahead of time to identify most desirable locations for this study. Try to pick areas that are away from student traffic.

A Population

Lab (To The Student)

OBJECTIVE:

The purpose of this activity is to identify a population in a community of plants and predict the approximate number of individuals in the population.

MATERIALS:

meter sticks
40 meters of yarn or string
4 stakes about 50 cm in length

PROCEDURES:

1. Select an area on the school yard where several different kinds of plants are growing. Measure a 10-meter square area and place a stake at each corner. Tie the string or yarn to the tops of the stakes to outline the square.
2. Each of 10 groups of students will be assigned a one-meter square area picked randomly by the teacher. The teacher will point out a species of plant to the class. Each team will count the number of these plants in its square. Record this number. Also, record the number of different species in the square. When all students have collected their data, return to the classroom.
3. The teacher will write the collected data from each group on the chalkboard. Enter this data in the following chart.

Data Chart

	Name or Sketch of Species	No. of Selected Organisms Found in Groups 1	2	3	4	5	6	7	8	9	10	Total Number Found	Average Number Found	Approximate Number in Total Plot
1)														
2)														
3)														
4)														
5)														

4. Calculate the approximate number of the selected species of plant in the 10-square meter area studied.
   a. Add the answers from all groups for species No. 1 and record your answers.
   b. Find the average number of species No. 1 plants by dividing the total number found by 10. Record your answer.
   c. Multiply the total number of groups reporting by the average number found to determine the approximate number in the plot.
   d. Sample problem: 1) in 10 squares there are 130 dandelions
      2) divide by 10 for an average of 13 dandelions per square
      3) multiply 10 x 13 for a total of 130 dandelions in the whole test plot
5. Repeat procedure above for each species selected by your teacher.
6. Answer the questions below on clean notebook paper and be prepared to discuss your answers.
   a. In a plant community, what is a population? Explain.
   b. Based on the answers arrived at, which species seems to do best in this population?
   c. Why do you think some species have a higher count in this test plot than other species?

Postlab (To The Teacher)

TEACHER OBJECTIVES:

- To help the students identify a population within a community of plants and derive a definition for population and community from their observations.
- To have the students predict the approximte number of individuals in a population.

SUGGESTIONS FOR ACCOMPLISHING THE OBJECTIVES:

Discuss with the students the distinction between population and community. Point out that even though the different species of plants make up a community and grow in the same area, each species may fill a separate niche.

ANSWERS TO QUESTIONS IN PROCEDURE 6:

a. A population is the number of individual plants of one species in a specified area.
b. Answers will vary according to locations; however, chart results will show highest counts of a particular species.
c. Answers will vary. Higher counts may be due to better adaptation to the soil environment as well as to climatic conditions.

Using Color To Survive In Nature

Prelab (To The Teacher)

- During the activity, students will work alone on an individual basis but will share findings in a group session upon completion of the outdoor portion of the activity.

- This activity helps the student understand the importance of color as a factor affecting the survival or removal of an animal from its native environment. The activity also allows the student to understand how animals use mimicry as a means of survival, when otherwise they would be removed from environment.
- This activity is designed to be done outside, preferably in a natural surface such as a green or brown grassy area.

- You will need to assemble the following materials for use pior to class:

  *a. 100 cm of yellow, plastic craft strip
  *b. 100 cm of brown, plastic craft strip
  *c. 100 cm of green, plastic craft strip
  *d. 100 cm of white, plastic craft strip
  *e. 100 cm of red or blue, plastic craft strip
  f. 1 roll of string and a plastic black felt-tip marker
  g. 4 wooden stakes, about 20 cm long

  *Available from hobby shops

  You will need a set of plastic strips (items a through e) for each class taking part in this investigation. Items f and g may be used repeatedly.

- Prepare the strips for use: take one yellow strip and cut it in half. Take one half of the strip and cut it into four-cm pieces. Take the other half, lay it down on a piece of paper, and color one side of it black with a felt-tip marker. Then cut this second half of the yellow strip into four-cm pieces.

- Proceed to cut one strip of each of the remaining colors into four-cm pieces so that you will have 125 four-cm pieces if you use five colored strips. Mix all the pieces you have cut together.

- Prior to the class period, scatter the strips inside the square area setup on the school grounds.

- Discuss with your students how in nature birds feed upon insects. Birds will feed on some insects but not on others, perhaps because of inability to see the insects due to their coloring or because of the taste associated with the coloring. Some birds do not eat certain insects as they are undesirable in taste. Thus other insects try to mimic these as lookalikes to keep from being eaten by birds, such as in the case of Viceroy and Monarch butterflies.

- Inform the students that they will play the role of birds in a natural environment seeking insects (strips of plastic). As they hunt the insects, they are not to pick up those that are yellow because they do not "taste good." They may pick up any other color insect.

- Take the class out to the area and line the students up around the edges of the square. Upon your signal, allow them to collect as many of the strips as possible, except for the yellow ones which are undesirable to them. At the end of the specified time period (perhaps five minutes), reassemble in the classroom.
- In the classroom, have each student sort out collected strips into color groups and prepare a count of each to report to the class.
- Have each student report his or her counts and tabulate them on the board for all to see.

Using Color To Survive In Nature

Lab (To The Student)

OBJECTIVE:

The purpose of this investigation is to be able to describe how protective coloration and mimicry can be a means of survival in nature.

MATERIALS:

This worksheet and a pencil.

PROCEDURES:

1. Listen to the instructions your teacher gives you to carry out this activity.
2. Go to the nature area designated and wait for further instructions to begin working.
3. At the area, collect as many "insects" as you can, following the rules, in the time period allowed.
4. Return to the classroom and count the number of each color of "insect" you collected or preyed upon. Give your answers in the chart below.

Color	Number Found	Reasons for Number You Found

5. Now give the results counted by the entire class.

Color	Total Class Count

6. Answer the following questions on clean notebook paper.
   a. Which color was most readily picked up?
   b. Why was this?
   c. Is the color of an insect related to what a bird preys upon?
   d. Why didn't the "bird" prey upon the yellow "insects"?
   e. Why didn't the "bird" prey upon the yellow-black "insects"?
   f. Which color survived the most?
   g. Why did they survive?
   h. Do predators have anything to do with helping nature see that some prey survives for the future?
   i. In this activity, did you see an example of one "insect" mimicking another "insect"? Explain.

Postlab (To The Teacher)

TEACHER OBJECTIVES:

- To help the students see the predator-prey relationship that existed in this activity.
- To discuss the class results so all may begin to see a trend developing in the data table of results.

SUGGESTIONS FOR ACCOMPLISHING THE OBJECTIVES:

- Go over the responses to the questions in Procedure 6 to review students' formation of thought.

ANSWERS TO QUESTIONS IN PROCEDURE 6:

a. On a green to brown grassy surface, the white and red strips would be seen most readily (also the yellow; however, the students were instructed not to pick them up because they did not "taste" good).
b. They were most readily picked up because of their light color, and they did not blend in with the background of the environment.
c. Yes, birds do select insects by color when preying on them.
d. The bird did not prey on the yellow insect because the bird knew beforehand that it tasted bad.
e. The yellow-black insect looked yellow, and the bird equated it with the all yellow, bad tasting insect, thus leaving it alone.
f. The color to survive most would be green, black, or brown. (It would depend on the color of the plot area you chose outside.)
g. They survived because their color blended in with the background they were on, thus going unnoticed by the birds.
h. Yes, predators select certain prey, thereby allowing others to escape to the environment and to survive.
i. Yes, the yellow-black insect mimicked the yellow insect, thus surviving. (In nature we see this happen with the Viceroy and Monarch butterflies.)

Earthworms: Responses To Stimuli

Prelab (To The Teacher)

- This investigation uses live earthworms that are to be observed by the students. It is important that the worms remain moist, otherwise they will die.
- This investigation can also be used to introduce stimulus and response.
- Obtain the live earthworms from local distributors in your community.
- Prior to the lab period fo this activity, assemble an ample supply of pans, probes, flashlights, and swabs for small group activities.
- Discuss the concepts of stimulus and response with your students to develop these fundamental ideas.

Earthworms: Responses To Stimuli

Lab (To The Student)

OBJECTIVE:

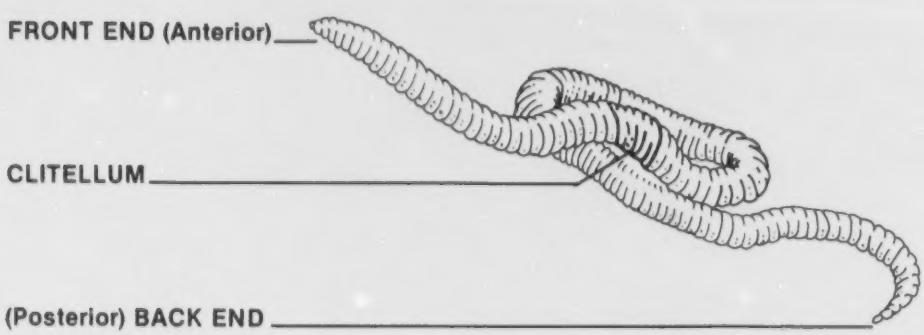
The purpose of this investigation is to observe an earthworm and its reponses to stimuli.

MATERIALS: (per group)

live earthworm
shallow pan
probe or dissecting needle
small flashlight
household ammonia
vinegar
paper towels
cotton swabs

PROCEDURES:

1. Soak the paper towels in water. Remove the excess water from the towels and cover the bottom of the pan with the towels.
2. Place an earthworm on the damp towels. It is important to keep the towels and earthworm damp.
3. Study the worm and locate the parts of the worm as they are labeled below.



4. Use the probe to lightly touch the front end of the worm. Record in the data table your observations of the worm's response.
5. Use the probe to lightly touch the back end and then the side of the worm. Record your observations of the worm's response to both stimuli.
6. Cover the worm with a damp towel and let it rest for several minutes. Raise the towel and shine a flashlight on the front end of the worm. Record your observations below.
7. Cover the worm again and let it rest for one or two minutes. Lift the towel and shine the flashlight on the back end of the worm. Replace the towel. Record your observations.
8. Dip a cotton swab in the ammonia. Remove the towel and hold the swab as close as possible to the worm without touching it. Replace the towel. Record your observations.
9. Take another cotton swab and dip it in the vinegar. Again, hold it as close as possible to the worm without actually touching it. Record your observations.

DATA TABLE

Stimulus	Response
Probe—Front end (anterior)	
Probe—Side	
Probe—Back end (posterior)	
Light—Front end (anterior)	
Light—Back end (posterior)	
Ammonia	
Vinegar	

10. Answer the following questions on clean notebook paper.
    a. How did the worm's responses differ when it was touched with the probe on the front, back, and side?
    b. Were the responses to touch alike in any ways? If so, name the ways.
    c. Which responded more to light—the front end or the back end?
    d. Did the earthworm move toward or away from the light?
    e. Did the worm respond to ammonia? If so, why?
    f. Did the worm respond to vinegar? If so, why?

Earthworms: Responses To Stimuli

Postlab (To The Teacher)

TEACHER OBJECTIVES:

- To provide an opportunity for students to observe a live earthworm and identify its front end, back end, and clitellum.
- To help students relate a certain stimulus to the corresponding response of an earthworm.

SUGGESTIONS FOR ACCOMPLISHING THE OBJECTIVES:

1. Compare the data collected by the students. Did all the students observe the same responses when using a given stimulus?
2. Lead a discussion about the responses of the earthworm and how they relate to the behavior of the worm in nature. For example, the response the earthworm elicited to the stimulus of light could explain why one seldom sees an earthworm on the surface of the ground during daytime.

ANSWERS TO QUESTIONS IN PROCEDURE 10:

a. The worm was more aggressive in its response when touched at the front end as compared to the side and back end.
b. Yes, body contractions should occur at the moment of touch.
c. The front end should respond more to the light.
d. The worm should move away from the light source.
e. Yes. The ammonia vapors irritated the nerve endings in the skin causing the worm to move away.
f. Yes. Same answer as above.

Behavior And Environment

Prelab (To The Teacher)

- Discuss stimulus-response behavior with examples from several organisms. Stress that general environmental factors affect environment.

- Discuss that the organism used in this experiment is a crustacean that is found in a dark, semimoist environment living off humus in the soil.

- Explain the construction of the humidity gradient chamber to be used in this activity by having the students analyze the "Pill Bug Racetrack" diagram. Explain the phrase "humidity gradient."

- With student help, gather the following materials.

  For each group of two students:
  Pill bug racetrack (to be made by students—see diagram)
  Piece of cardboard 24 cm x 76 cm long (one for each racetrack)
  2 baby food jars with perforated lids
  Graph paper cut to size of racetrack
  Cobalt test paper strips and cotton balls
  2 sheets of graph paper

  For entire class:
  1 lb. dessicant (calcium carbonate or calcium sulphate)
  Small bottles of nail polish, colored lacquer, or liquid paper, of different colors
  Watches or 1 wall clock with second hand
  White liquid glue
  Roll of masking tape or plastic tape
  Desk lamp
  1 roll of clear plastic wrap

- Plan to use a minimum of one class period to construct racetracks and one 24-hour period to allow the chamber to stabilize the humidity inside.

Behavior And Environment

Lab (To The Student)

OBJECTIVES:

The purpose of this investigation is to identify stimuli and to measure the reactions of pill bugs to various stimuli, to observe the paths made by pill bugs in a humidity gradient chamber, and to state inferences based upon observations made in this activity.

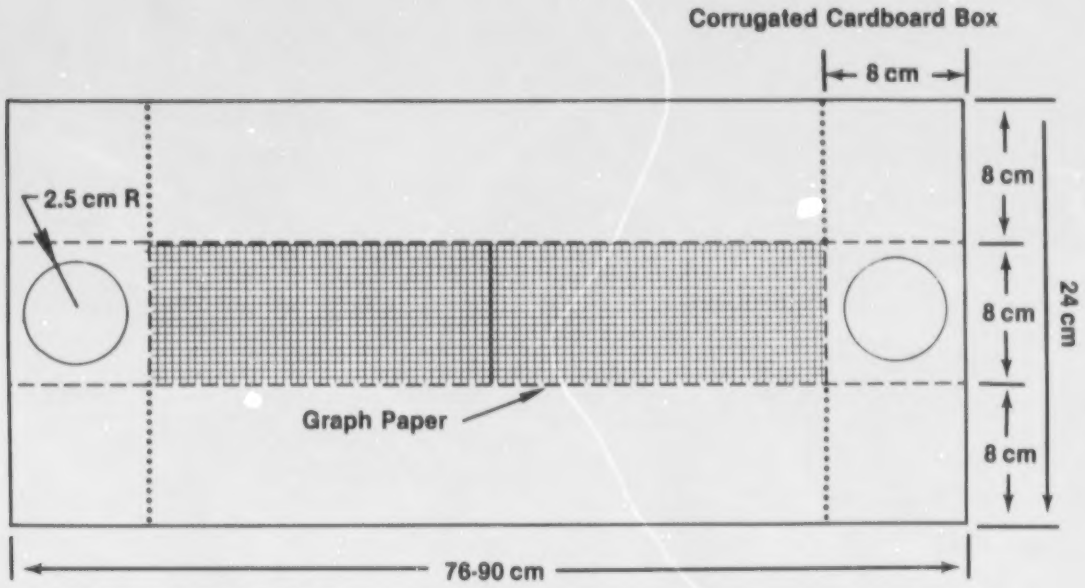
MATERIALS (For each group of two students):

cardboard, size 24 cm x 76 cm
2 baby food jars with lids
3 sheets graph paper
cobalt test paper strips
dessicant (calcium carbonate or calcium sulfate)
cotton balls
clear plastic wrap
masking tape
white liquid glue
live pill bugs

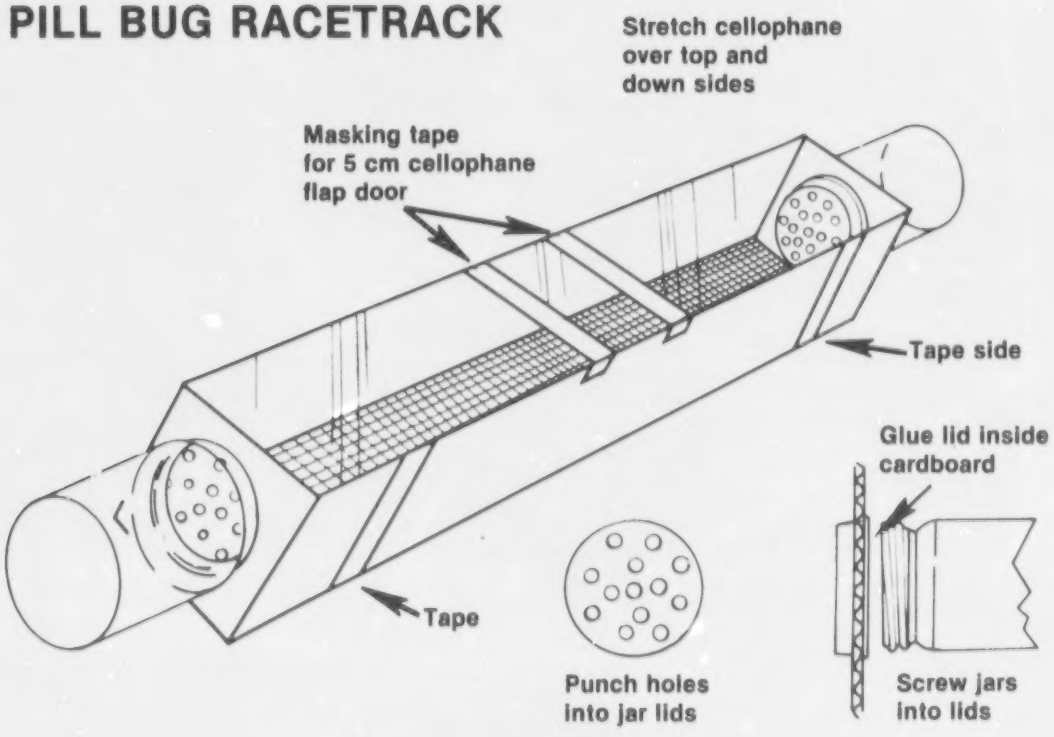
PROCEDURES:

1. Collect several pill bugs from moist places, under leaves. Keep them in a coffee can along with their natural soil and leaves. Put a small piece of raw potato on top of the soil. Cover with a plastic lid.
2. Using the Pill Bug Racetack diagram (page 72), assemble an experimental humidity gradient chamber. The chamber should be tightly sealed to maintain the humidity gradient. To establish a gradient chamber, place the dessicant in a jar at one end and moist cotton balls in a jar at opposite end and leave for 24 hours. NOTE: The dessicant should be dried before you use it.
3. Place cobalt chloride test strips inside the racetrack chamber near the ends to serve as indicators of moisture. Cobalt chloride test strips will be blue when dry; pink when wet or moist. Place the test strips in the middle and at both ends of the chamber.
4. Place a 60-watt desk lamp over the top of the chamber to make sure that the chamber is uniformly lighted.
5. Using the directions in Procedure 2 and the control gradient racetracks, do the following:

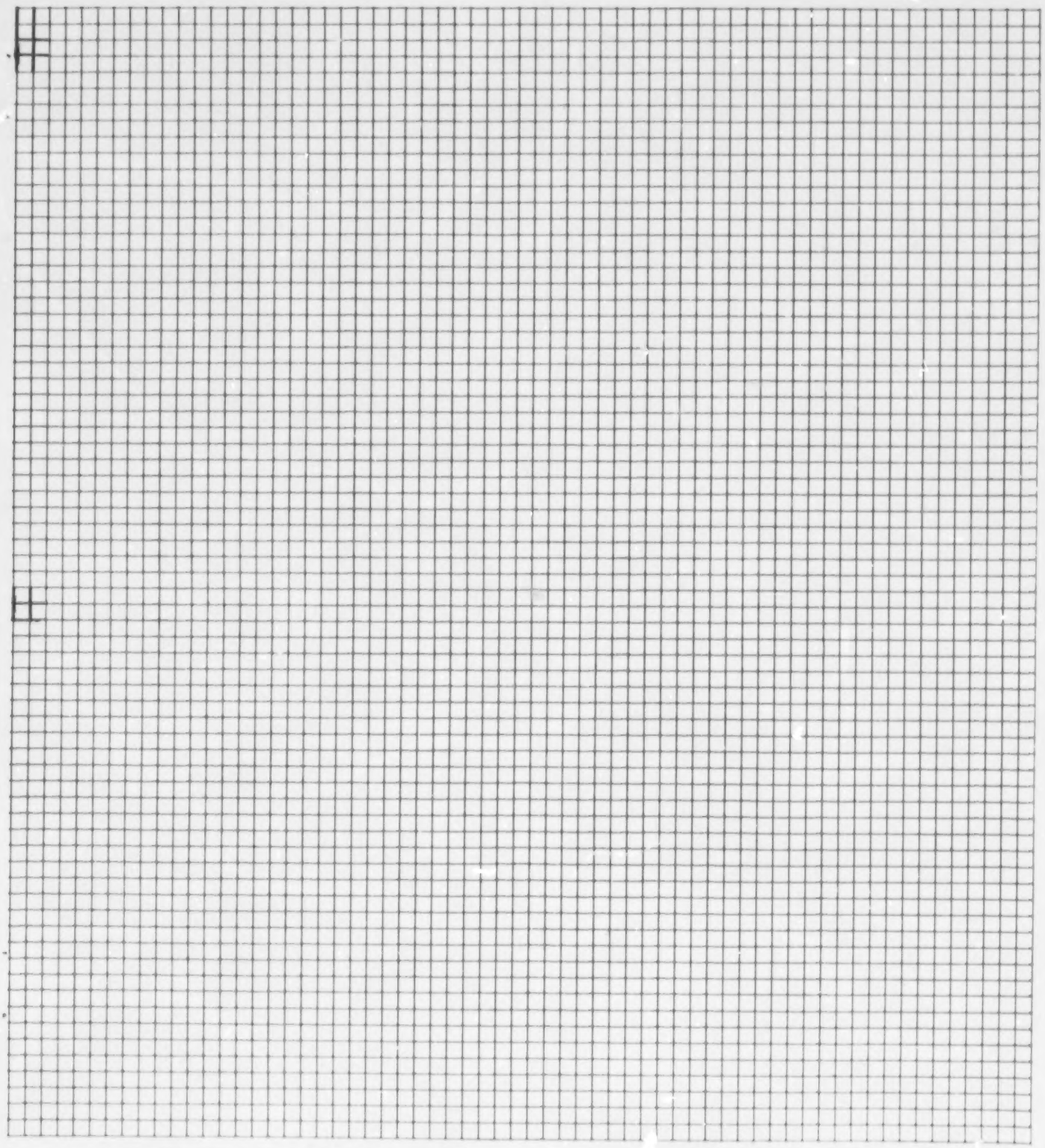
   Mark a pill bug's back by dipping a pencil in nail polish. Mark another pill bug with another color. Carefully place the pill bugs into the racetrack through the openings at the top of the chamber. Allow them three minutes to become used to the box. During this time, cut a piece of graph paper to the size of the base of the racetrack and place it outside the track, parallel to the inside graph. Use a clock or wristwatch with a second hand and observe the pill bugs move inside the chamber. Draw the movements of the pill bugs in the chamber on your graph paper outside the chamber. Draw the paths of movement as accurately as possible. Mark one end of the graph paper "Moist" and the other end "Dry." Measure the time the pill bugs stay in one-half of the chamber. Record this time on the back of the graph paper. Also, record other behaviors observed.
6. Answer the questions below on clean notebook paper.
   a. Are pill bugs more prone to stay in the humid or dry end?
   b. Were there some pill bugs that did not respond by moving to either end?
   c. What differences in the speed of movement in either end did you observe if any?



PILL BUG RACETRACK


Stretch cellophane over top and down sides
Masking tape for 5 cm cellophane flap door
Tape side
Glue lid inside cardboard
Tape
Punch holes into jar lids
Screw jars into lids

GRAPH PAPER FOR PILL BUG RACETRACK



Behavior And Environment

Postlab (To The Teacher)

TEACHER OBJECTIVES:

- To help the students recognize that animals behave in varying ways, depending on the conditions of the environment.
- To stress that animals will respond to stimuli as a means of survival.
- To assist students in forming suitable inferences based on recorded observations.

SUGGESTIONS FOR ACCOMPLISHING THE OBJECTIVES:

1. Allow members of each group ample time to observe and study the graph recording they made while racing their pill bugs.
2. Have groups discuss and compare their results with each other and formulate inferences on how the pill bug responds to the stimuli in the chamber.
3. Review the group inferences with the entire class to establish that a general trend actually exists.
4. Have groups repeat this activity, this time varying the stimuli to include: light-dark; hot-cold; etc.

ANSWERS TO QUESTIONS IN PROCEDURE 6:

a. Humid end is the most likely answer because pill bugs' natural habitat is moist.
b. Yes, because of various times for acclimation or differences in moisture-dry conditions inside the racetracks. Some pill bugs may display random movement.
c. Pill bugs should naturally go toward moisture at a rapid rate, but once there, movement should slow down. Also a smooth, dry surface may allow pill bugs to move more rapidly than a moist surface.

Ants And Their Senses

Prelab (To The Teacher)

- Prior to this laboratory experience students should have a general understanding of the structure and function of the olfactory system.

- The following materials need to be obtained prior to class. Per group:
  cardboard
  metric ruler
  sugar cubes
  graph paper
  ants
  cotton swab
  scissors
  water
  collecting bottles
  watch with a second hand
  medicine dropper

- Time allowance for this experiment is one 45-minute class period. Time may vary depending upon the students' ability to locate the needed invertebrates for the activity. If this lab is used during a period of time when ants are unobtainable, an ant farm can be prepared well in advance to ensure the needed ants at the time of the activity. If an ant farm is not available, use a large container with a perforated lid to keep ants available until needed.

- This activity will help students determine the importance of smell in invertebrates (ants) in food gathering.
  NOTE: Not all animals use their sense of smell in food gathering. Some (certain birds) have no sense of smell; therefore, food gathering in these animals is strictly by sight.

Ants And Their Senses

Lab (To The Student)

OBJECTIVES:

The purpose of this investigation is to determine that senses are important to animals (ants) in food gathering and to graph the data obtained in this activity.

MATERIALS:

cardboard
scissors
metric ruler
graph paper
sugar cubes
water
manila folder
watch with a second hand
collecting bottle with lid
5 ants (to be obtained from out-of-doors)
medicine dropper
cotton swab

PROCEDURES:

1. Measure and cut five strips of cardboard, 28 cm x 13 cm each.
2. Make graduated marks beginning with 5 cm; continue to mark each 5 cm through 25 cm on each cardboard.
   SEE EXAMPLE BELOW

3. Use strips of manila folder, 3 cm wide, to make sides on each strip of cardboard to prevent the ant from leaving the experimental area. Use tape to secure strips to cardboard.
4. Each of the pieces of cardboard should be numbered, using numbers 1 through 5. When complete, line the strips up next to each other.
5. On cardboard Number 1, place a moistened sugar cube (use one drop of water) on the 5-cm mark; on cardboard Number 2, place the sugar cube on the 10-cm mark; on Number 3, place the sugar on the 15-cm mark; on Number 4, place the sugar cube on the 20-cm mark; and on Number 5, place no sugar on the cardboard.
6. Take your collecting bottles out-of-doors and collect five ants. Remember, ant bites may cause a reaction, so CAUTION is advised.
7. Place one of the ants on cardboard Number 1. Locate the ant in the center of the cardboard at the 0-cm mark. Use a clean cotton swab stick to transfer the ant to the cardboard.
8. Begin timing the ant to determine the length of time it requires for the ant to reach the food. Record the time it took the ant to reach the sugar cube.
9. Continue this procedure with each piece of cardboard, using different ants on each board. Should the ants deviate from the course, start them at point zero and begin again.
10. Using the graph provided, plot the distance in centimeters and the time in minutes required for each ant to make its journey. Use different-colored graph marks to represent the ants tested by a student group.

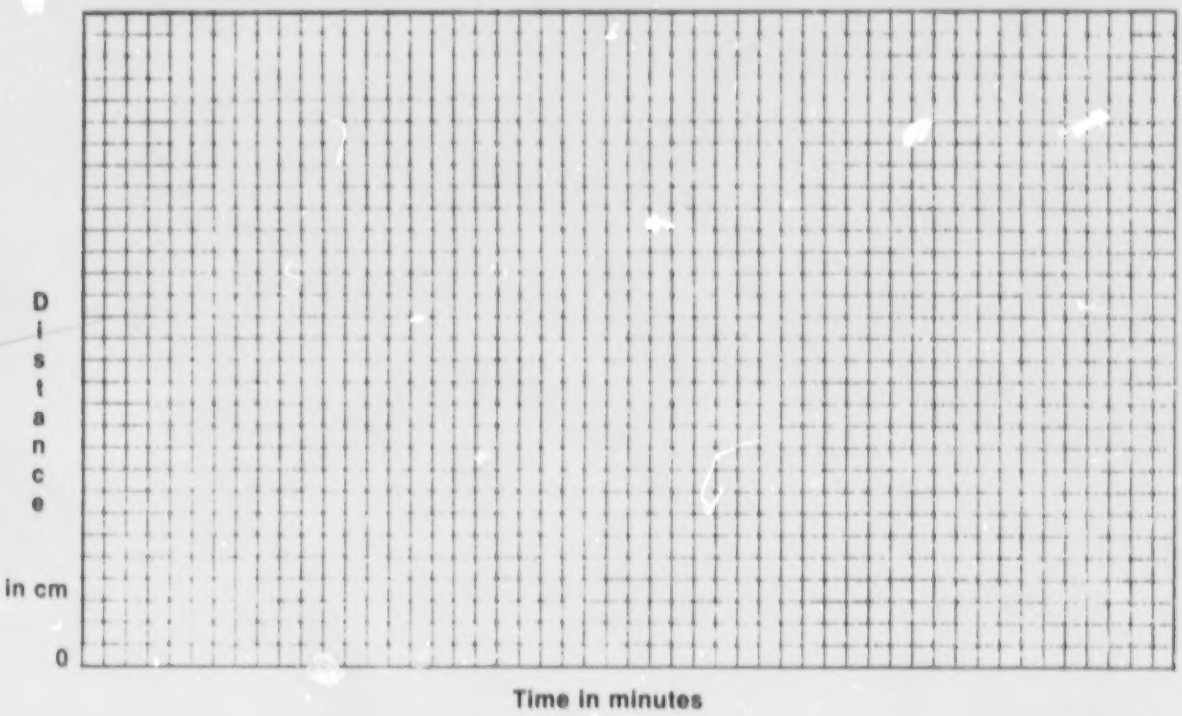
DATA TABLE:

Student Group No. _____

Distance to sugar cube in cm. Time in seconds are minutes.

5 cm	
10 cm	
15 cm	
20 cm	
25 cm (control)	

GRAPH



11. Answer the following questions on clean notebook paper.
    a. Did some ants seem to move faster than others? Explain.
    b. Did your ants go directly to the sugar cube?
    c. What is the stimulus in this activity?
    d. Why was there no sugar placed on cardboard Number 5? Explain.
    e. How do your results compare with the other groups' results in your class? Explain.

Ants And Their Senses

Postlab (To The Teacher)

TEACHER OBJECTIVES:

- To assist students in developing an understanding of the use of senses in obtaining food.
- To formulate general inferences based on student data.

SUGGESTIONS FOR ACCOMPLISHING THE OBJECTIVES:

1. Allow each group ample time to observe and record the movements of the ants being tested.
2. Have groups discuss and compare their results and graphs.
3. Discuss differences that occurred, even though students followed the same procedures.
4. Plan to vary this activity by using another animal and/or food source.
5. This activity may be varied by building a maze out of shoe box and performing the same procedures.

ANSWERS TO QUESTIONS IN PROCEDURE 11:

a. Answers will vary. Some may move faster as some may be more aggressive or excitable.
b. Answers will vary.
c. The stimulus is the food source you used.
d. Cardboard Number 5 served as a control to compare time and distance.
e. Answers will vary. However, a general trend should appear in the class results.

Humus In The Soil And Its Effect On Growth Of Plants

Prelab (To The Teacher)

- Prior to this investigation the teacher should discuss:
  - decay and how it releases important minerals such as nitrogen in the soil so root systems of plants can absorb and utilize the minerals in their growth and development
  - the substance, nitrogen, in decaying plants and animals (humus) that causes plants to grow more rapidly
- The humus (in this case ground insects, grass clippings, rice, etc.) should be allowed to stand for a few days so it will have a chance to decay.
- This investigation contains a control. Be sure the students know the meanings of "control" and "experimental" in a lab siutation.
- Refer to materials listed on page 80 to see what you must have available to begin the activity. Give students several advance days to have the humus prepared.

Humus In The Soil And Its Effect On Growth Of Plants

Lab (To The Student)

OBJECTIVE:

The purpose of this investigation is to demonstrate the need growing plants have for humus in the soil.

MATERIALS (per group):

clean builder's sand (enough for 3 flower pots)
package viable bean seeds
humus such as:
- grass clippings
- bean seeds, groundup
- breakfast cereal
- rice
- insects, groundup

3 flower pots (or milk cartons)
graph paper

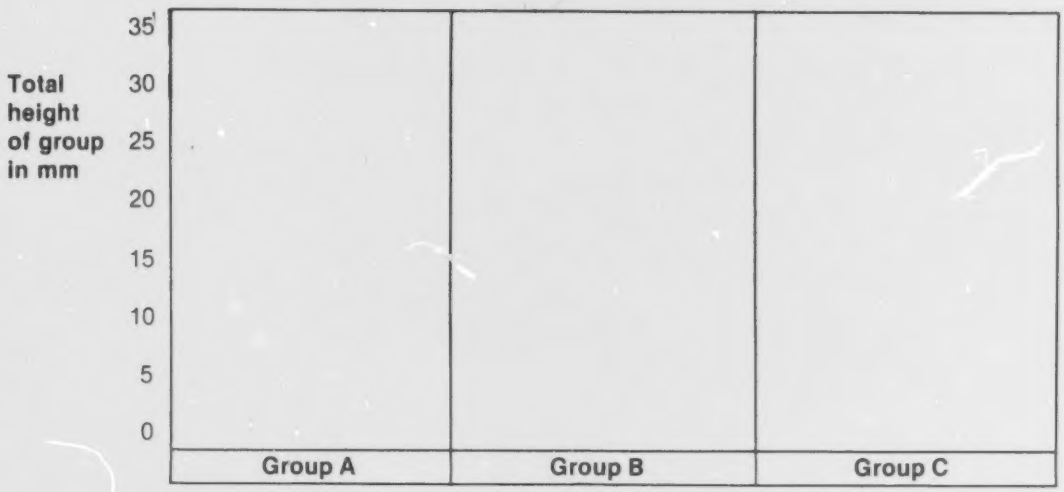
PROCEDURES:

1. Divide the builder's sand into three samples. Place the samples into the flower pots. To the first sample, add a soaked bean seed about 2.5 cm below the surface of the soil. Label this Group A (the control).
2. To the second sample of sand add a mixture of groundup cereal and insects, rice, beans, and grass clippings. Plant a soaked seed 2.5 cm below the surface. This is Group B.
3. To the third sample, add a mixture of ground cereal and insects, rice, beans, and grass clippings that have been allowed to stand in water for several days. Pour off the liquid and add the solid humus to the sand. Plant a soaked bean seed 2.5 cm below the surface. This is Group C.
4. Water all three groups daily with equal amounts of water.
5. All conditions such as light, moisture, temperature, and pot size must be the same for Groups A, B, and C.
6. After the seeds germinate and are visible above the surface of the ground, the cotyledons should be removed to assure that all mineral requirements needed by the plant come from the soil.
7. After the seeds have germinated, measure the plant heights and leaf sizes each day for Groups A, B, and C. Observe the plants daily and record the color of the plants in all groups.
8. Graph the height of the plants in Groups A, B, and C. Show only total height attained, using a different color for each group.
9. Answer the following questions on clean notebook paper.
   a. Did the experimental plants in Groups B and C grow more or less in height than the control plants in Group A?
   b. Of all three groups, which one showed the greatest amount of growth?
   c. Why was it necessary to allow the humus to stand several days before using it?
   d. How did the color of the plants compare in the three groups?
   e. If all of your seeds did not germinate and grow, explain possible reasons why.

DATA TABLE:

Growth Day	Group A		Group B		Group C	
	Height/mm	Color	Height/mm	Color	Height/mm	Color
1						
2						
3						
4						
5						
6						
7						
8						

BAR GRAPH:



Humus In The Soil And Its Effect On Growth Of Plants

Postlab (To The Teacher)

TEACHER OBJECTIVES:

- To help the student identify the function of decomposers.
- To provide an opportunity for students to observe differences between the control and experimental plants.

SUGGESTIONS FOR ACCOMPLISHING THE OBJECTIVES:

1. Allow sufficient time for this experiment. Perhaps five days of growth after germination would show enough variation in the three groups. If not, allow more time.
2. Graphs should be compared for Groups A, B, and C. They should provide the basis for a discussion of the differences between experimental and control plants.
3. Always relate differences in the size and color of the plants to the experimental treatment of Groups B and C and the control.
4. Lead a discussion in which common decomposers are named. Also, the function of decomposers could be discussed in relation to producers and consumers.
5. The same kind of experiment could be developed using a variety of humus resources such as bone meal, cream of wheat, and sawdust to determine the rate of decomposure.

ANSWERS TO QUESTIONS IN PROCEDURE 9:

a. Organic materials should have allowed for more plant growth in Groups B and C than in Group A that received only water.
b. Group C with the humus left standing should have grown the fastest.
c. Standing allowed for decay to occur thus releasing essential nutrients for growth.
d. Control Group A plants should have more coloration than those in Groups B or C.
e. Some seeds may not be viable and would not germinate. Excessive moisture in pot may deter or inhibit seed growth.

Photosynthesis In Plants

Prelab (To The Teacher)

- Students are to work in groups of two.
- This investigation is designed to help the student visualize basic actions that occur during the process of photosynthesis in green plants. This is made possible through the use of a chemical indicator.
- Prior to class, assemble the following materials for each two students:

  5 test tubes, preferably 150 mm in length
  5 stoppers to fit test tubes
  1 soda straw
  100 ml of tap water that has been stored overnight
  3 four-inch sprigs of elodea plant (green)
  1 piece of aluminum foil to completely cover one tube
  a 75 to 100 watt light source
  5 pieces of freezer tape to label tubes
  test tube rack or jar to hold tubes upright
  dropper bottle of bromthymol blue indicator

- Elodea or anacharis plants may be obtained at local variety stores that sell aquarium fish or may be obtained from freshwater streams in some areas.
- Bromthymol blue is an indicator that changes from yellow to blue when the pH of water changes from 6.0 to 7.6. At 6.0 it will be yellow, and at 7.6 it will be blue. It may be purchased directly in solution form from science supply companies. A 0.04 percent solution works well.
- Set out the tap water in jars or a plastic bucket the day prior to the activity.
- In class, develop the concept of photosynthesis in plants using the basic equation:
  green plant + carbon dioxide + water + sunlight $\longrightarrow$ starch + oxygen
- Emphasize the need for basic ingredients for the process to occur.
- Help students understand that starch is a form of energy the plant stores within itself and that oxygen is a byproduct the plant gives off as a gas into the environment.
- Have the students respond to these questions:

  a. How do green plants differ from animals?

Plants	Animals
Usually have roots, stems, and leaves	Have none of these
Contain chlorophyll for green or yellow colors	Contain no chlorophylls
Take in carbon dioxide	Give off carbon dioxide
Give off oxygen to the environment and use some for respiration	Use oxygen for respiration

b. Why are green plants green?

Green plants contain chemical pigments called chlorophylls that account for the green to yellow-green colors.

c. What is necessary for plants to grow?

Plants need minerals, water, carbon dioxide, sunlight, and oxygen to sustain their life processes.

- It might be helpful to show the students what happens when one exhales in water containing a tint of bromthymol blue indicator. Using a straw, bubble through the blue solution; the water will turn to a yellowish green after about two or three minutes. This indicates that the pH of the water has changed.

- When students perform the following investigation, they should notice: (1) the color change of the tinted water and (2) the formation of gas bubbles on the elodea leaves.

Photosynthesis In Plants

Lab (To The Student)

OBJECTIVES:

The purpose of this investigation is to determine that raw materials are necessary for photosynthesis to occur and for students to see plant processes take place, using a chemical indicator.

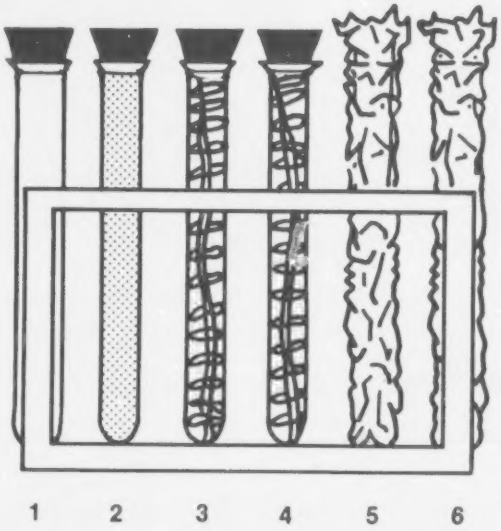
MATERIALS. You will need:

6 test tubes
6 stoppers to fit tubes
1 soda straw
100 ml of tap water left out overnight
4 sprigs of elodea, each about 10 centimeters long
2 pieces of aluminum foil to cover 2 tubes
bright lamp source
freezer tape
test tube rack or jar to hold tubes up
dropper bottle of bromthymol blue indicator

PROCEDURES:

1. Thoroughly clean six test tubes and rinse each at least three times.
2. Place a piece of freezer tape on each tube, then number them 1, 2, 3, 4, 5, and 6.
3. Place about 140 ml of tap water in a beaker or jar.
4. Add about 30 drops of bromthymol blue indicator to the water to tint it blue.
5. Fill Test Tubes 1, 3, and 5 with the blue water and place them on the rack. Fill to the top (see diagram).

1. Blue water
2. Yellow-green water
3. Blue water and elodea
4. Yellow-green water and elodea
5. Blue water, elodea, and aluminum foil
6. Yellow-green water, elodea, and aluminum foil



6. Take a soda straw and bubble carbon dioxide from your breath into the remaining blue water you have left in the beaker. Do this for about two or three minutes until the blue water changes to a yellow-green color.

90

7. Fill Test Tubes 2, 4, and 6 with the yellow-green water.
8. To Test Tubes 3, 4, 5, and 6, add a sprig of elodea.
9. Stopper all six text tubes.
10. Wrap Tubes 5 and 6 with aluminum foil.
11. Place tubes in front of light source for 24 hours. Place light source about 50 cm away from tubes.
12. Observe tubes after 24 hours as to color changes and gases collected at top. Use white paper behind tubes as a background to view true color of liquids.
13. Fill in data chart to show contents and color change of each tube you prepared.

DATA CHART:

No.	Color and Contents	24-Hour Observations
1		
2		
3		
4		
5		
6		

14. Answer the following questions on clean notebook paper.
    a. How can you tell if photosynthesis has taken place in your experiment? Explain.
    b. In 24 hours, what change if any took place in Tube 3? Why?
    c. Does Test Tube 5 differ from 3? Explain.
    d. What does the color change mean after the 24-hour period?
    e. Was there any change in the amount of gas at the top of each tube after 24 hours?
    f. Which tube best shows that photosynthesis took place and why?
    g. What is the purpose of Test Tubes 1 and 2?
    h. Compare Tubes 5 and 6 after 24 hours. Explain.
15. Now, take apart your setup, clean all equipment used, and return it to storage. Clean up work.

Photosynthesis In Plants

Postlab (To The Teacher)

TEACHER OBJECTIVES:

- To help students understand that light energy is necessary in the process of photosynthesis.
- To review the basic processes that occurred.

SUGGESTIONS FOR ACCOMPLISHING THE OBJECTIVES:

1. Compare various test tubes from different groups to establish results that occurred.
2. Discuss changes, if any, in each test tube.
3. Use a chalkboard or overhead projector to formulate class results.
4. Discuss possible reasons for variations that may have occurred contrary to general results.

ANSWERS TO QUESTIONS IN PROCEDURE 14:

a. Test Tube 4 should have a color change in the liquid from yellow-green to blue, and many gas bubbles should be visible around the sprig. Also more air space should have formed at the top of the tube.
b. No visible changes took place. The carbon dioxide present is insufficient to cause a color change.
c. No. There is no significant color difference.
d. The color change after 24 hours means that the pH of the water changed and that the plants removed the carbon dioxide from the water turning it back to blue again.
e. Tube 4 showed the greatest increase in gas collected at the top of the tube.
f. Tube 4 best shows that photosynthesis took place because the tube contained all the raw materials (green plant, carbon dioxide, sunlight) necessary.
g. They serve as controls, indicating that the liquid by itself did not cause a color change.
h. Test Tube 5 remains blue while Test Tube 6 should exhibit a color change.

Effects Of Detergents On Growth Of Algae

Prelab (To The Teacher)

- Many of the commercial detergents used in homes have a stimulating effect upon the growth of algae.
- The increased growth of algae (algae bloom) has a number of unfavorable effects upon the balance of plant and animal organisms in bodies of fresh water:
  - Algae can use up the oxygen supply needed by fish and smaller aquatic organisms.
  - Sunlight cannot penetrate the algae.
  - Algae blocks proper drainage and may cause stagnation.
- Discuss the types of water pollution such as chemical, thermal, and bacterial.
- Describe algae and its importance in the food chain within ponds, streams, and lakes.
- Familiarize students with basic algae structure, such as unicellular, colonial, and multicellular forms.
- You may want to have the student groups use various brands of detergent to determine if there is any difference in the effect they have on the growth of algae.

The Effect Of Detergents On The Growth Of Algae

Lab (To The Student)

OBJECTIVE:

The purpose of this investigation is to control variables and to demonstrate the effect of commonly used washing detergent on the growth of algae in fresh water.

MATERIALS:

2 grams of detergent
2 one-gallon wide-mouth jars
culture of fresh water algae
1 balance
4 liters of tap water (aged 24 hours)
1 light source, such as a table lamp
1 graduated cylinder

PROCEDURE:

1. Add two liters of aged water to a gallon jar, and dissolve two grams of detergent in the water.
2. Add 20 ml of green algae culture to this jar. Label this jar "Experimental."
3. Without adding the detergent, repeat Procedures 1 and 2 with another jar. Label this jar "Control."
4. Cover the jar tops and allow them to stand, side by side, about one-half meter from a 100-watt lamp.
5. Observe the jars twice a week for two or more weeks.
6. Describe in writing the color and appearance of the contents of each jar, each week. Keep a record of your observations.
7. Answer the following questions on clean notebook paper.
   a. What were the differences, if any, between the experimental and the control?
   b. What purpose did the light source serve in this experiment?
   c. Which solution best compares to a polluted body of water?

Effect Of Detergents Of Growth Of Algae

Postlab (To The Teacher)

TEACHER OBJECTIVES:

- To guide the students as they perform the experiment on the effects of detergents on algae.
- To provide an opportunity for the students to interpret the data from the lab and relate that data to people's effect on the ecosystem.

SUGGESTIONS FOR ACCOMPLISHING THE OBJECTIVES:

1. Discuss the color of the algae growing in the detergent solution as compared to the color of algae in water. The algae grown in detergent should appear greener. Because of overcrowding, some algae in which light could not penetrate may not be as green or may appear unhealthy.
2. A possible extension of this investigation is to have students examine the water and algae from the control and experimental jars under the microscope. Record and discuss variations.
3. Students can place several minnows in small containers, one that contains a thick growth of algae and a second with a moderate growth. Observe differences.
4. Discuss ways we can stop polluting ponds and streams. Solutions will vary but may include such strategies as passing laws to prevent detergent contamination or development of purification methods to remove detergents from sewage before it is allowed to enter ponds and streams.

ANSWERS TO QUESTIONS IN PROCEDURE 7:

a. The experimental jar will show a thicker growth of algae than the control. The algae grown in detergent solution may appear greener in color than the control.
b. The lamp was used as a light source for the algae to carry out "photosynthesis," whereby food was made to generate algae growth.
c. The detergent jar most closely resembles a polluted body of water.

Digestive Heat

Prelab (To The Teacher)

- This investigation helps relate enzyme activity to the breakdown of foods during the process of digestion and explains the subsequent release of energy in the form of heat.
- A chemical change will occur when you add liver to hydrogen peroxide which releases heat.
- The chemical reaction occurs because the liver contains an enzyme known as catalase that is characterized by its readiness to decompose hydrogen peroxide while slowly being destroyed itself. The formula for the reaction of hydrogen peroxide with the enzyme catalase is as follows: $2H_20_2 \xrightarrow[\text{catalase}]{} 2H_20 + 0_2$. The oxygen immediately combines to form oxygen molecules and these bubble off, causing foaming. This catalase enzyme is present in animal and vegetable tissues.
- Hydrogen peroxide turns to water on standing. Be sure you buy a new bottle (3 percent solution) prior to this activity. Predetermine how much you will need. (Approximately 75-100 ml will be needed per class of 15 two-member teams.)

Digestive Heat

Lab (To The Student)

OBJECTIVE:

The purpose of this investigation is to observe and measure the energy released in a chemical change.

MATERIALS:

test tube
test tube rack
liver (raw, beef)
graduated cylinder, small
watch or clock, with second hand
thermometer
hydrogen peroxide (3 percent solution)

PROCEDURES:

1. Pour five ml of hydrogen peroxide into a test tube.
2. Record the temperature of the hydrogen peroxide in the test tube.
3. Remove the thermometer.
4. Add a piece of liver about the size of a pencil eraser to the five ml of hydrogen peroxide.
5. Replace the thermometer and record the temperature of the liver and hydrogen peroxide every 30 seconds for six minutes.
6. Repeat this activity three times.

TRIAL	STARTING TEMPERATURE	TEMPERATURE AFTER ADDING LIVER — Minutes									
		0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
1											
2											
3											
4											
Total											
Average											

7. Answer the following questions on clean notebook paper.
   a. Was there a temperature change after adding the liver to the hydrogen peroxide?
   b. Can you give proof that a chemical change took place?
   c. What was the highest temperature change achieved?
   d. Why is it important to repeat the experiment?
   e. During the investigation, hydrogen peroxide was changed into water and oxygen. Did you observe anything to suggest that oxygen was given off? Explain.

Digestive Heat

Postlab (To The Teacher)

TEACHER OBJECTIVE:

To help the students relate the temperature changes in the digestive process.

SUGGESTIONS FOR ACCOMPLISHING THE OBJECTIVES:

1. Have students compare test results with results of other groups.
2. Have the students discuss how the body temperature of 37°C is maintained.
3. Have the students identify other processes related to digestion and heat release.
4. Introduce the function of enzymes.

ANSWERS TO QUESTIONS IN PROCEDURE 7:

a. Yes, there is a temperature change after adding liver to hydrogen peroxide.
b. Yes, because the temperature changes.
c. Answers will vary but the maximum temperature should be reached in the first two minutes.
d. It is important to repeat the experiment to be certain of accuracy in results.
e. Yes, bubbles were seen in the hydrogen peroxide. These could be oxygen.

Action Of Enzymes On Milk

Prelab (To The Teacher)

- This investigation should familiarize the student with the role enzymes play in the process of digestion.
- Enzyme action is necessary in the coagulation of milk protein.
- Before beginning the investigation, introduce the following words that may be new to the students:
  Mammals—class of vertebrates that nourish their young with milk
  Coagulation—the change from a liquid to a thickened curdlike state
  Protein—essential amino acids needed by animals
  Enzyme—substance that speeds up chemical action in digestion of foods
  Rennin—an enzyme that coagulates milk
- The following materials will be needed to perform the investigation (per small group):
  ice
  720 ml milk
  72 ml sugar
  1 rennin tablet
  plastic pan (ice bath)
  3 small plastic cups
  hot plate (or a heat source)
  thermometer, optional
  spoons or stirring rods
- Rennin tablets can be found at most stores. Ask for junket rennin tablets.
- If you want to allow students to sample the prepared mixture, it is important to stress using clean containers, stirring rods, etc.
- To chill the mixtures, a container filled with ice will be sufficient if no refrigerator is available.

Action Of Enzymes On Milk
Lab (To The Student)

OBJECTIVE:

The purpose of this investigation is to observe that enzymes are essential for certain chemical changes to occur.

MATERIALS:

720 ml milk
72 ml sugar
1 rennin tablet
vanilla
ice
3 small plastic cups
hot plate (or a heat source)
spoons or stirring rods
beakers 250 ml or larger
(optional) thermometer
plastic pan (ice bath)

PROCEDURES:

1. Combine 24 ml of sugar with 240 ml of milk and 10 drops of vanilla in a 250 ml beaker Mix thoroughly.
2. Heat contents to lukewarm (43°C). Stir as you heat. CAUTION: do not overheat contents.
3. Crush one-half rennin tablet and dissolve in eight ml of water.
4. Add rennin solution to lukewarm solution and stir for a few minutes.
5. Pour at once into a clean cup. Place cup into ice bath for 10 minutes.
6. Repeat above process again. In Procedure 3, bring the rennin solution to a boil, then continue with Procedure 4. Pour entire contents into Cup 2. Chill cup and contents.
7. Again, repeat the above procedure the third time, this time without adding rennin to the mixture. Pour into Cup 3 and chill as before.
8. Answer the following questions based on what you observed during this investigation.
   a. Did the boiled rennin react the same as the unboiled rennin solution?
   b. What happened when the rennin was omitted from the mixture?
   c. Was the ice bath responsible for thickening your three mixtures? Explain.
   d. What role, if any, does rennin play in your stomach?

Action Of Enzymes On Milk

Postlab (To The Teacher)

TEACHER OBJECTIVES:

- To guide the students as they review the results of this activity.
- To provide students with an opportunity to relate their observations to enzyme actions.

SUGGESTIONS FOR ACCOMPLISHING THE OBJECTIVES:

1. Have students compare their observations with those of members of other groups.
2. Discuss the following with your students.
   a. Mammals, particularly young ones who feed on large quantities of milk, have an enzyme in their gastric juice that promotes the coagulation of milk protein.
   b. Rennin is used commercially in the making of cheese and pudding.
3. You may desire to alter this activity for your students in the following way:

   To the white of an egg, add an equal amount of water. Heat gently to lukewarm (43°C). Do not overheat. Crush one-half tablet of rennin and disperse in water. Add the rennin solution to the egg white and stir for several seconds. Cool and let stand for 10 minutes. Compare the activity of milk protein to that of the egg protein.

   The class could be divided into two groups with one group to follow the procedure above and the other half to follow the procedure described on page 00. Then students could compare results.

ANSWERS TO QUESTIONS IN PROCEDURE 8:

a. No. The milk with the boiled rennin did not thicken as the rennin lost its ability to act upon the milk.
b. The milk without the rennin did not thicken because the enzyme was absent.
c. No. Two of the three mixtures did not thicken in the ice bath.
d. Rennin is necessary in the digestion of milk in the human stomach.

Hereditary Traits

Prelab (To The Teacher)

- Each trait is determined by at least one pair of controlling factors. These factors are in the genes or chromosomes.
- Capital letters are used to represent dominant factors and lower case letters are used to represent recessive factors.
- Many traits are not clearly dominant or recessive but involve a number of possibilities. The possibilities range from clearly showing the trait to not showing it at all.
- If you have PTC paper available, have students do PTC taste tests. Cut each strip of PTC paper into three or four parts to make the paper go farther. Then have the students all begin together. Do not tell them what reaction to expect.

Hereditary Traits

Lab (To The Student)

OBJECTIVE:

The purpose of this investigation is to predict certain inherited traits.

MATERIALS:

PTC test paper
beakers
filter paper (cut to same size at PTC paper)
paper cups
water
mirror

PROCEDURES:

1. There are two basic types of ear lobes, attached and unattached. Using a mirror, observe your ear lobes.

ATTACHED

UNATTACHED

2. Record your ear lobe type by writing "yes" or "no" in the squares of the data table for "attached" and "unattached."
3. Now find the number of students in the class who have ear lobes attached/unattached and record this information in the data table.
4. Figure out what percentage of students in the class have each trait studied in this activity. For example, if there are 30 students in the class and six of them have attached ear lobes, divide six by 30. Now multiply by 100 to get the percentage.
5. Follow the same procedure for the trait of tongue rolling.

ROLLER

NONROLLER

Stick out your tongue and see if you can roll the side up. Record by writing "yes" or "no" in the squares marked "tongue roller" or "tongue nonroller." Record the totals for the class, and find the percentages for both tongue rollers and tongue nonrollers.

6. Follow the same procedure for the trait of a cleft (a deep groove) in the chin.

CLEFT

NO CLEFT

Record by writing a "yes" or "no" and then record the totals for the class. Find the percentages for both chin cleft and no chin cleft.

7. Follow the same procedure for the trait of a widow's peak in the hairline.

WIDOW'S PEAK

NO WIDOW'S PEAK

Record by writing a "yes" or "no" and then record the totals for the class. Find the percentages for both no widow's peak and widow's peak.

8. Put a piece of filter paper in your mouth and chew it. Move it around, especially to the back of the tongue. Record a description of the taste.
9. Put a piece of PTC test paper in your mouth and repeat as in Procedure 8. Record the description of the taste.
10. Record whether or not you are a PTC taster by writing "yes" or "no" in the square "PTC taster" and "PTC nontaster" in the chart. Also record the totals for the class and find the percentages for both squares.

DATA TABLE:

	Trait	I have	Number in class who have	Percentage of class who has the trait
1	ear lobes attached			
	ear lobes unattached			
2	tongue roller			
	tongue nonroller			
3	chin cleft			
	no chin cleft			
4	widow's peak			
	no widow's peak			
5	PTC taster			
	PTC nontaster			

11. Answer the following questions on clean notebook paper.
    a. According to your data table, which one of each of the five pairs of traits is more common in the class?
    b. Of the common traits found in Question A, list the ones that you have yourself.

Postlab (To The Teacher)

TEACHER OBJECTIVES:

- To help the students determine hereditary traits that are common in the class.
- To help the students determine the dominant and recessive traits studied in this activity.

SUGGESTIONS FOR ACCOMPLISHING THE OBJECTIVES:

1. First have the students determine which trait they have, then discuss which traits are dominant and which are recessive.
2. In this investigation, the traits are as follows:

Dominant	Recessive
unattached ear lobes	attached ear lobes
tongue roller	tongue nonroller
chin cleft	no chin cleft
widow's peak	no widow's peak
PTC taster	PTC nontaster

3. Discussion of dominant and recessive traits in this investigation will provide a foundation for another investigation that could be entitled *Determining the Chance of Offspring Having Brown or Blue Eyes.*

ANSWERS TO PROCEDURE 11:

a. For each trait observed, answers will vary depending upon the makeup of your class.
b. Answers will vary. (Each student will identify traits common to that individual, thus allowing for a means of comparison to generalized class traits.)

Reproduction and Growth

Prelab (To The Teacher)

- At the end of the activity, the student should be able to: describe how animals reproduce and grow, determine various levels of structural organization, and measure size and changes with a ruler and graph the changes observed.

- Materials that will be needed per class include:
  fertilized eggs from hatchery (21)
  baby food jars with tops
  weak alcohol or formaldehyde solution for each jar (8 percent solution)
  *electric incubator
  scale or balance
  *If no incubator is available, then you will need the following items:
  small aluminum pan for water
  centigrade thermometer
  light cord
  light bulbs (40, 60, 75 watt)
  freezer tape
  6 cm x 8 cm glass or plastic (clear plastic wrap could be substituted)
  two cardboard boxes with tops (one 20 cm x 12 cm x 12 cm and another large enough to hold the first)
  newspaper for insulation

- The incubation period for quail eggs (which make a good substitute for chicken eggs) is approximately 21 days. Duck eggs hatch in 26 to 28 days.

- Eggs from a grocery store are usually not fertile and are not to be used in this activity.

CAUTIONS:
Be sure the light cord students use is safe and doesn't have frayed wires.

Reproduction And Growth

Lab (To the Student)

OBJECTIVE:

In this investigation, you will watch and measure the growth and development that takes place inside a fertilized egg.

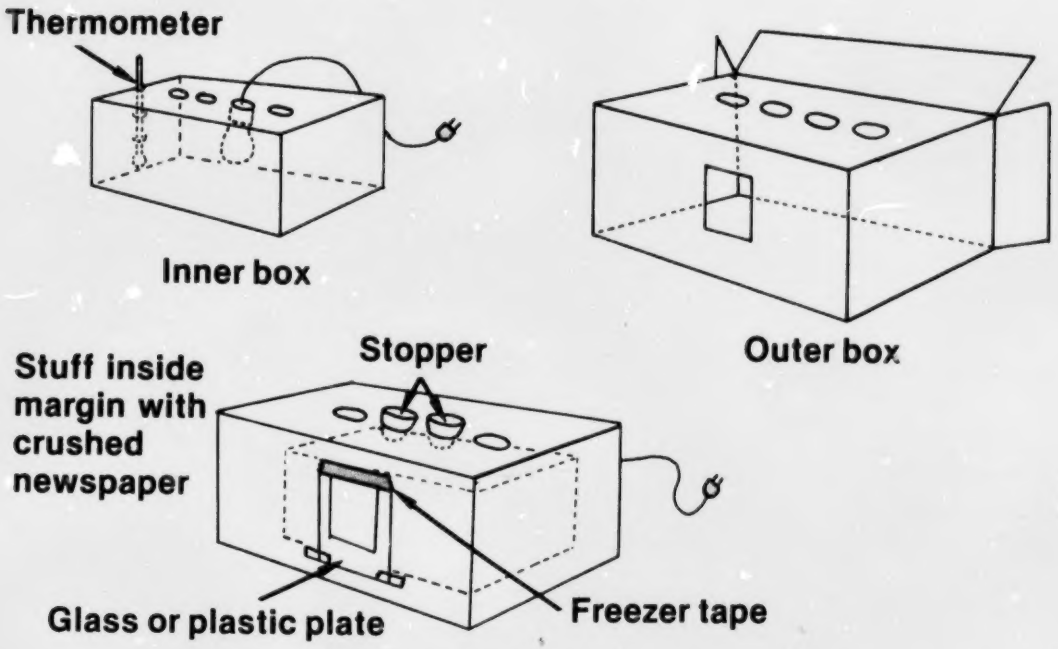
MATERIALS:

fertilized eggs from hatchery (21)
baby food jars with tops
weak alcohol or formaldehyde solution for each jar (8 percent solution)
*electric incubator
scale or balance
*If no incubator is available, then you will need the following items to make one as per procedures below (see diagram):
small aluminum pan for water
centigrade thermometer
light cord
light bulbs (40, 60, 75 watt)
freezer tape
6 cm x 8 cm glass or plastic (clear plastic wrap could be substituted)
two cardboard boxes with tops (one 20 cm x 12 cm x 12 cm and another large enough to hold the first)
newspaper for insulation

PROCEDURES:

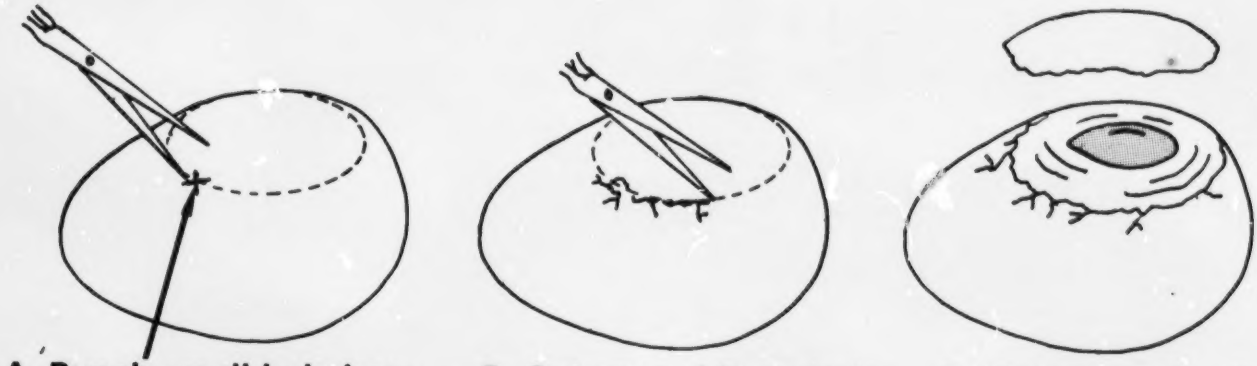
1. If you do not have an incubator you will need to construct one using two cardboard boxes, one about 20 cm x 12 cm x 12 cm and another large enough to allow the first box to fit inside with ample room to spare on all sides. Once you have assembled the boxes, stuff crushed newspaper in the ample outer margin to completely insulate the inner box. Insert a light into the top of the inner box so that it dangles downward inside. Cut a small square hole through both box layers for viewing purposes. Insert the thermometer into the top of the inner box with the bulb at the same level as the eggs when they are in the incubator. Use an aluminum pan with water to prevent the eggs from drying out.
2. After you finish construction, turn on the light and leave it on for one hour. After this time, note the temperature in the incubator. Try bulbs of different sizes until the temperature in the incubator remains constant at 39°C. Make holes through the tops of both boxes, and either plug or unplug them until the temperature comes to rest at 39°C. Do not put the eggs in the incubator until the temperature remains constant at 39°C for a couple of days.

INCUBATOR CONSTRUCTION DIAGRAM



3. When you obtain your eggs, candle each one to determine if they are actually fertile. This may be done by placing each egg over a hole cut into the bottom of an inverted empty juice can that has been placed over a light bulb. Fertile eggs will show a dark spot near the yolk.
4. After candling, place all eggs in cartons and close. Place in the preheated adjusted incubator. Support carton on edge so that the long axis of the eggs will lie in a horizontal position. Turn the eggs over daily. If the investigation is being performed at school, begin incubating on a Monday morning as this will allow observation on Tuesday through Friday.
5. The eggs should then be labeled with the time and date. Each egg should be candled every second day to observe and measure the growth. When eggs are being candled, you can measure the approximate size of the embryo with a ruler and record it on a chart. Using the graph provided, plot the size of the embryo against the incubating time. Be sure that the eggs are handled with clean hands and replaced immediately so as not to interrupt the incubating process.
6. Depending on the number of eggs you have, you will want to open them at specific times to observe the growth process. If you have 21 eggs that were fertilized at the same time, you can open one per day for 18 days. The procedure for opening the egg is shown in the diagram below.
7. After weighing the egg, carefully open the part of the shell that was facing upward. This can be done by punching a small hole into the shell with a pair of scissors. Continue opening by cutting around the top, creating a window of about 2.5 cm in diameter for observations. Each time you open an egg, refer to the Growth and Development Data Sheet and record your observation.

DIAGRAM FOR OPENING INCUBATED EGG

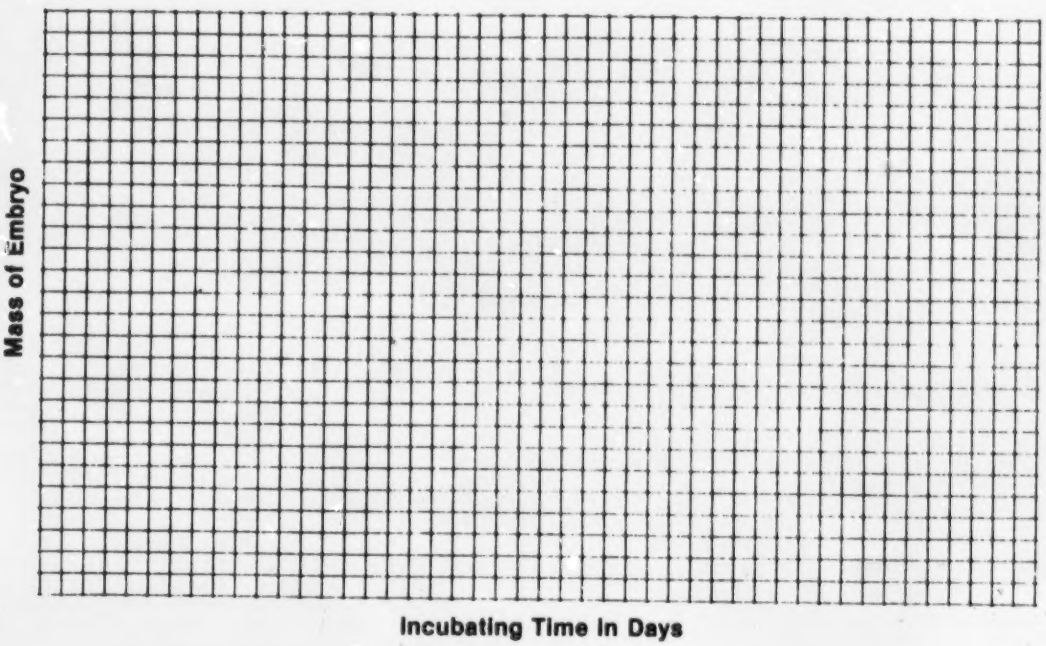


A. Punch small hole here B. Cut around in a circle C. Embryo and yolk

8. After you observe the chick embryo, it should be lifted from the yolk with forceps and snipped free with scissors. Transfer the embryo to a jar containing rubbing alcohol that has been diluted half with water. (If formaldehyde is available, use diluted solution instead of alcohol.) The embryo should then be weighed and the following measurements made:
   a. Mass of entire egg
   b. Mass of jar and alcohol
   c. Mass of jar, alcohol, and embryo
   d. Mass of embryo (subtract b from c)

9. Using the graph provided, plot the incubation time and mass. The mass should be marked along the left side of the graph and the time along the bottom of the graph.

Graph Of Incubating Time Versus Chick Size



10. Keep the jar lid tightly sealed so that none of the liquid evaporates. You should have observed all eggs by the twenty-first day. If you have eggs hatch on the eighteenth day, be sure to keep the baby chicks at a temperature of 27°C.

Growth And Development Data Sheet

ITEM	DATE FIRST OBSERVED	OTHER OBSERVATIONS
Blood Vessels		
Heart		
Head		
Feathers		
Muscles		
Feet		
Wings		
Legs		
Spinal Cord		
Yolk Sac Blood		
Heart Beating		
Beak		
Eye		

11. Answer the following questions on clean notebook paper.
    a. From your data table, which structural item appeared first in the development of the chick embryo?
    b. How long after incubation began did you first notice a heart beat?
    c. What was the source of nourishment for the growing embryo?
    d. Explain why the eggs are turned while they are incubating.

Postlab (To The Teacher)

TEACHER OBJECTIVE:

To assist students in sequencing structure formation during the development of the chick.

SUGGESTIONS FOR ACCOMPLISHING THE OBJECTIVE:

1. Review one or more prepared graphs to verify chick size during development.
2. With entire class, review the Growth and Development Data Sheet based on class findings.
3. Show a film on chick reproduction and growth, then relate film to the class investigation.
4. This investigation may be varied in the following ways:
   a. Observe the yolk as it disappears. Determine what percentage of the entire egg the embryo is as it grows. Keep a record of the increasing embryo percentage and the decreasing yolk percentages.
   b. Collect clumps of frog or snail eggs. (Frog eggs may be collected in the spring from ponds or streams.) Place about 20 eggs in a dish with pond water. Observe and keep a data log on frog or snail development on Mondays, Wednesdays, and Fridays. Put them in fresh pond water on Mondays and Fridays.
   c. Remove any eggs that have the white side up and seem to be dead. Observe and record the developmental growth of the animals. Compile a collection of student drawings of the developmental stages of the frogs or snails.

ANSWERS TO QUESTIONS IN PROCEDURE 11:

a. Generally the blood vessels will appear first.
b. Answers may vary based on class observation.
c. Source of nourishment for the embryo is the yolk.
d. Eggs are turned during incubation so as to allow the embryo a chance to change positions, thus allowing normal body development to occur.

Noise Pollution

Prelab (To The Teacher)

- Not everyone will agree what are sounds and what are noises. Establish class definitions of "sound" and "noise."
- The loudness of sounds is measured in decibels. Sounds of about 115-120 decibels may be painful to humans. Temporary deafness may result from short exposures in this range. Sounds beyond 150 decibels usually cause permanent hearing loss.
- You will need to have portable recorders available for this activity.
- Locate areas around campus prior to class suitable for recording various sounds.
- Use a sample tape in class to demonstrate how to record sound frequencies and to distinguish between sounds and noises.

Noise Pollution

Lab (To The Student)

OBJECTIVE:

The purpose of this investigation is to recognize that some sounds can be classified as a form of pollution called noise.

MATERIALS:

tape recorder
audio tape

PROCEDURES:

1. In an area designated by the teacher, sit quietly for five minutes and record all the different sounds that are heard.
2. Place a check mark in the Data Table every time the sound is heard so that there will be a record of the frequency.
3. In the noise column, write "yes" if it is noise, "no" if it is not a noise.
4. Compare your Data Table with that of your classmates.
5. If you have a tape recorder, record various sounds from the environment. Play the tape in class, and have the other students classify those sounds that are noises. Suggest the sources of the noises and ways to control them.

DATA TABLE:

Kinds of Sounds	Times Heard	Noise (Yes or No)

6. Answer the following questions on clean notebook paper.
   a. What does the word "noise" mean to you?
   b. Select three of the sounds listed as noise and tell how they might be controlled, reduced, or eliminated.
   c. Why did some students list certain sounds as noises and other students did not?
   d. What is a decibel and how is it related to noise pollution?
   e. What might happen to an individual if he or she is exposed to noise pollution for a short period of time? A long period of time?

Noise Pollution

Postlab (To The Teacher)

TEACHER OBJECTIVES:

To help the students recognize that there is a difference between sound and noise.

SUGGESTIONS FOR ACCOMPLISHING THE OBJECTIVES:

1. Have the students make a list of five sounds they would all agree should be classified as noise and five sounds they would all agree are sounds, not noise.
2. Invite the school nurse to demonstrate how to measure hearing.
3. Have interested students research regulations on noise levels for factories, protective devices for workers in these industries, and penalties for violations of the law.
4. Have students contact a local agency for the deaf to determine if any industries in the community hire deaf people because of noise pollution.

ANSWERS TO QUESTIONS IN PROCEDURE 6:

a. Answers will vary. Generally, noises are irritating to humans.
b. Answers will vary.
c. Each person perceives sound in a different way.
d. A decibel is a unit used to measure sound levels. Sounds with high decibels generally are identified as noise.
e. Temporary deafness may result. Extended exposure increases the duration of deafness to a point of possible total deafness.

Particulate Matter In The Air

Prelab (To The Teacher)

- The purpose of this investigation is to assist the student in understanding the nature and magnitude of air pollution in modern day environments. The activity gives first-hand contact with actual pollution in the atmosphere.
- Develop the concept of "air pollution" with your students in a discussion emphasizing:
  - some of the things that create air pollution today (dust from vehicles, smoke, chemical fumes, etc.)
  - problems generated by air pollution today (physical discomfort in breathing, asthma, restricted plant growth, deterioration or rusting of prepared surfaces)
- Caution the students to construct the collector exactly as instructed in the lab and not to touch the collection areas.
- Remind the students to record the dates and locations of their collection.
- Remind the students to anchor their collectors to prevent them from falling or blowing away.

Particulate Matter In The Air

Lab (To The Student)

OBJECTIVE:

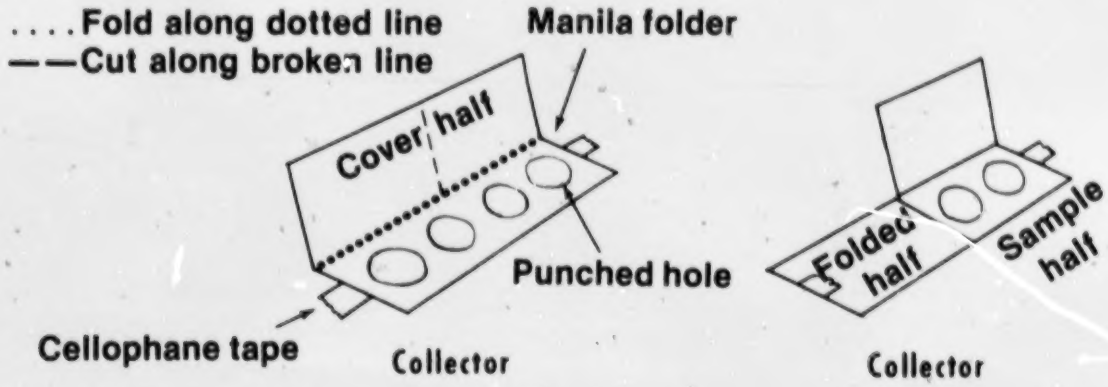
The purpose of this investigation is to collect and to determine the types and numbers of particles in the air.

MATERIALS:

scissors
metric ruler
transparent or cellophane tape
hole punch
compound microscope
manila folders or 3 x 5 cards

PROCEDURES:

1. Each student or group of students should construct four or more collectors. A collector is a strip of manila folder or a 3 x 5 card folded and cut to the size of a microscope slide (see diagram). Fold it in half lengthwise. Cut one side in half. Punch four holes through the uncut half of the collector and attach tape behind the holes, leaving some extending from each end of the collector. Tape down one-half of the top portion to serve as a control. Do not touch the exposed tape.



COLLECTOR

2. Place the folded collectors into a small envelope for storage and carrying. Collectors could be placed on window sills, porches, under house or store eaves, or on fences. Secure each collector with the sample half down and exposed. It is suggested that the collector be left at the site for four hours. Try to avoid places where collectors will be disturbed. When retrieving the collectors, record on the cover half the location it was placed and the date and time.
3. Observe the collector through a microscope. Compare the exposed half and the control half. Count the number of particles in the exposed fields. Compute the average for the collector by adding the total number of particles and dividing by two.
4. Answer the following questions on clean notebook paper.
   a. Where did you find the most particles? Why do you think this was so?
   b. What kind of particles were collected? Note the size, shape, color, and source (if possible) of particles.

Particulate Matter In The Air

Postlab (To The Teacher)

TEACHER OBJECTIVE:

To help the students make inferences concerning the particles in the atmosphere.

SUGGESTIONS FOR ACCOMPLISHING THE OBJECTIVES:

1. Have the students discuss the various possibilities of sources for the types of particles collected.
2. Have the students compare their collections and infer what the particles are.

ANSWERS TO QUESTIONS IN PROCEDURE 4:

a. More particles will be collected in collectors that are exposed to more open air.
b. Answers will vary.

COMPLIANCE STATEMENT

TITLE VI, CIVIL RIGHTS ACT OF 1964; THE MODIFIED COURT ORDER, CIVIL ACTION 5281, FEDERAL DISTRICT COURT, EASTERN DISTRICT OF TEXAS, TYLER DIVISION

Reviews of local education agencies pertaining to compliance with Title VI Civil Rights Act of 1964 and with specific requirements of the Modified Court Order, Civil Action No. 5281, Federal District Court, Eastern District of Texas, Tyler Division are conducted periodically by staff representatives of the Texas Education Agency. These reviews cover at least the following policies and practices:

(1) acceptance policies on student transfers from other school districts;

(2) operation of school bus routes or runs on a non-segregated basis;

(3) nondiscrimination in extracurricular activities and the use of school facilities;

(4) nondiscriminatory practices in the hiring, assigning, promoting, paying, demoting, reassigning, or dismissing of faculty and staff members who work with children;

(5) enrollment and assignment of students without discrimination on the basis of race, color, or national origin;

(6) nondiscriminatory practices relating to the use of a student's first language; and

(7) evidence of published procedures for hearing complaints and grievances.

In addition to conducting reviews, the Texas Education Agency staff representatives check complaints of discrimination made by a citizen or citizens residing in a school district where it is alleged discriminatory practices have occurred or are occurring.

Where a violation of Title VI of the Civil Rights Act is found, the findings are reported to the Office for Civil Rights, Department of Health, Education and Welfare.

If there is a direct violation of the Court Order in Civil Action No. 5281 that cannot be cleared through negotiation, the sanctions required by the Court Order are applied.

TITLE VII, CIVIL RIGHTS ACT OF 1964; EXECUTIVE ORDERS 11246 AND 11375; TITLE IX, 1973 EDUCATION AMENDMENTS; REHABILITATION ACT OF 1973 AS AMENDED; 1974 AMENDMENTS TO THE WAGE-HOUR LAW EXPANDING THE AGE DISCRIMINATION IN EMPLOYMENT ACT OF 1967; AND VIETNAM ERA VETERANS READJUSTMENT ASSISTANCE ACT OF 1972 AS AMENDED IN 1974.

It is the policy of the Texas Education Agency to comply fully with the nondiscrimination provisions of all federal and state laws and regulations by assuring that no person shall be excluded from consideration for recruitment, selection, appointment, training, promotion, retention, or any other personnel action, or be denied any benefits or participation in any programs or activities which it operates on the grounds of race, religion, color, national origin, sex, handicap, age, or veteran status (except where age, sex, or handicap constitute a bona fide occupational qualification necessary to proper and efficient administration). The Texas Education Agency makes positive efforts to employ and advance in employment all protected groups.